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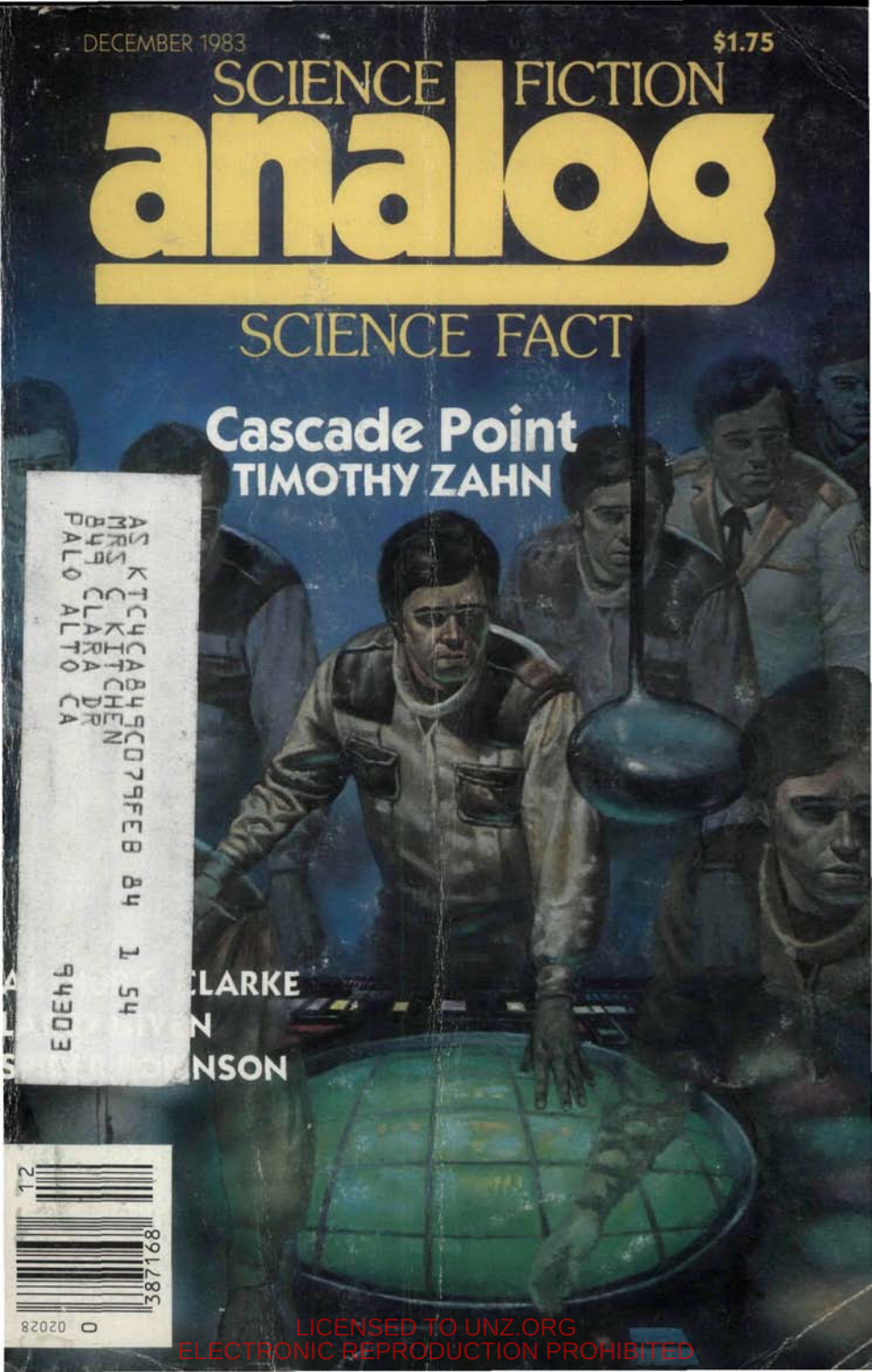

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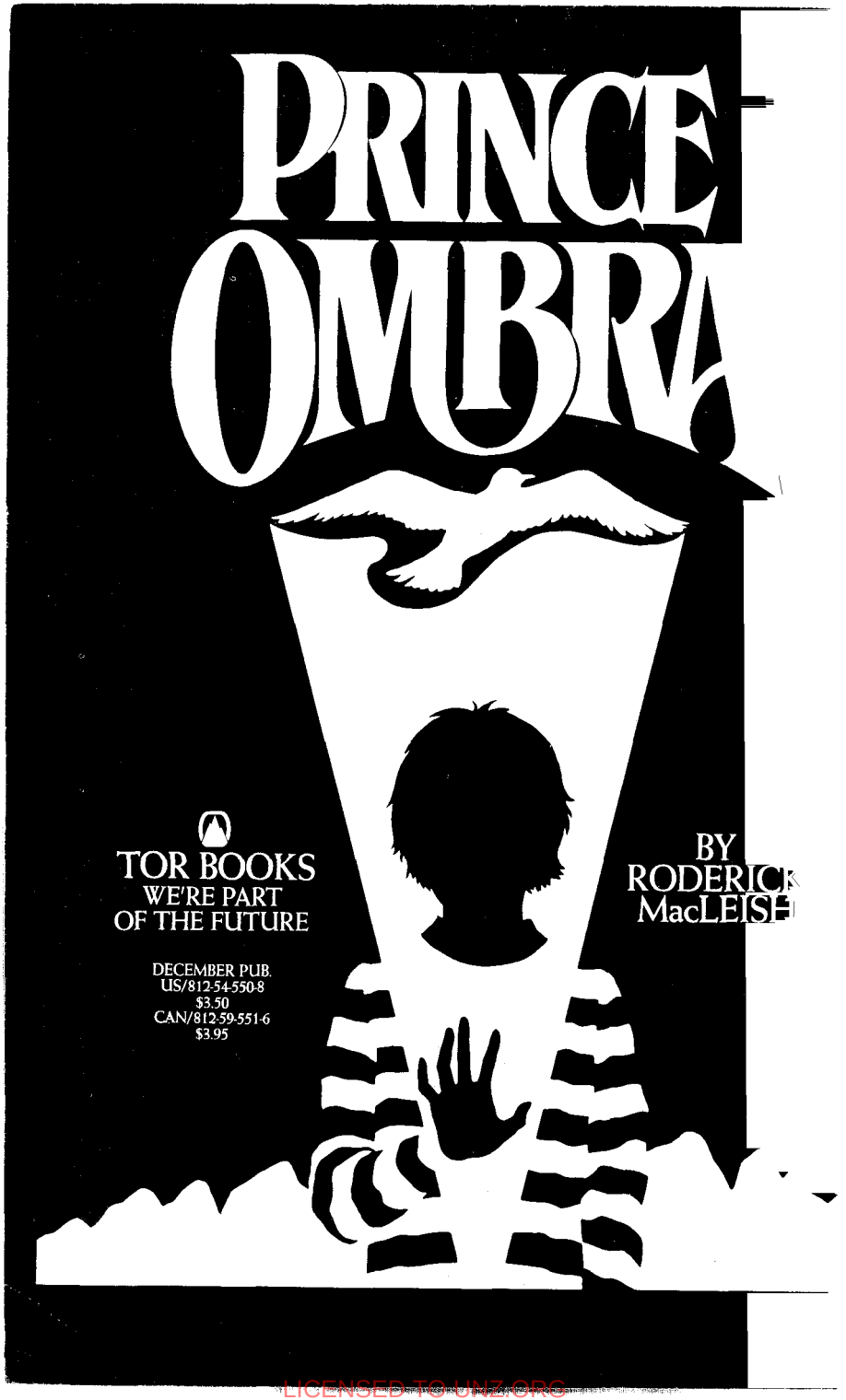

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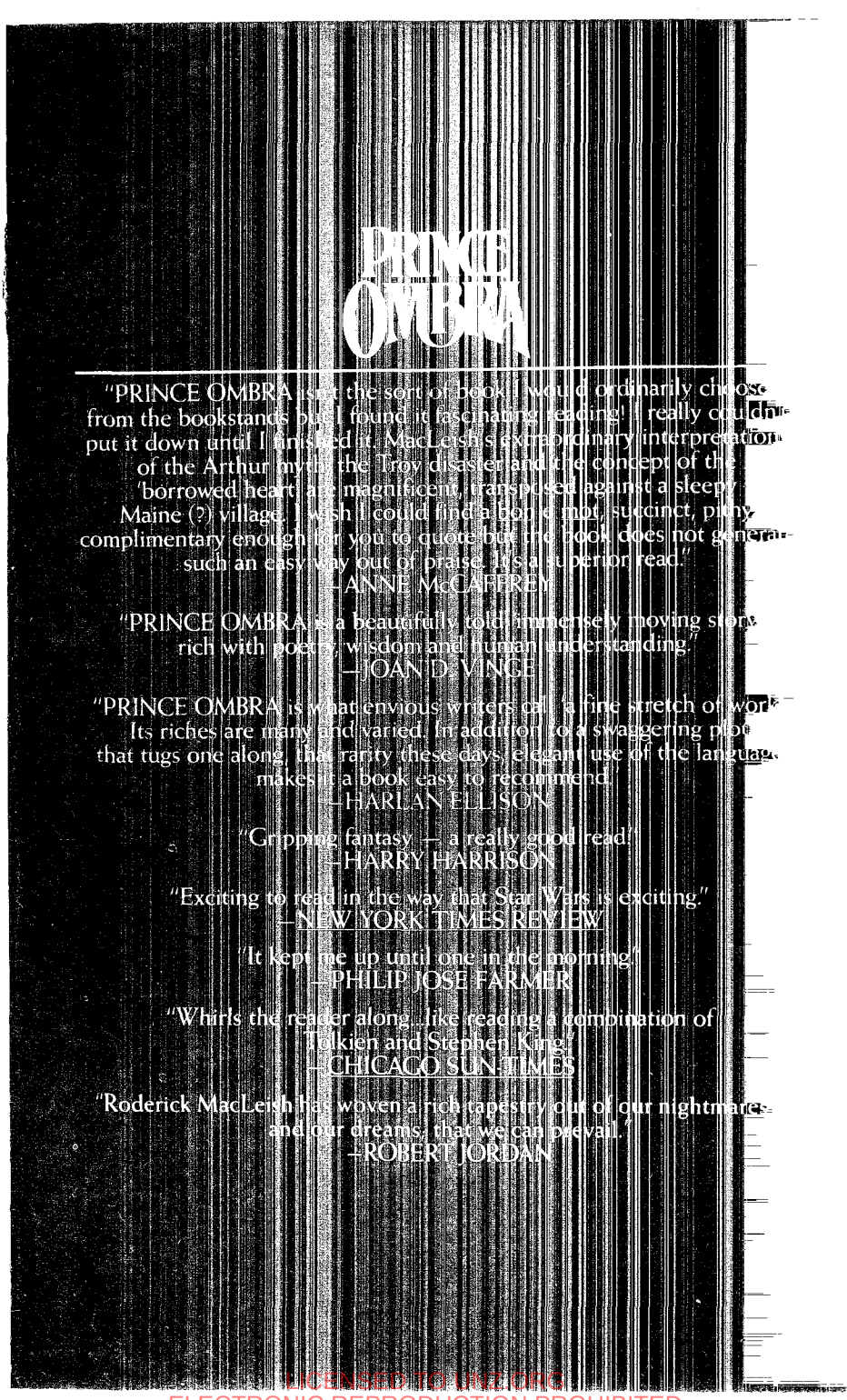

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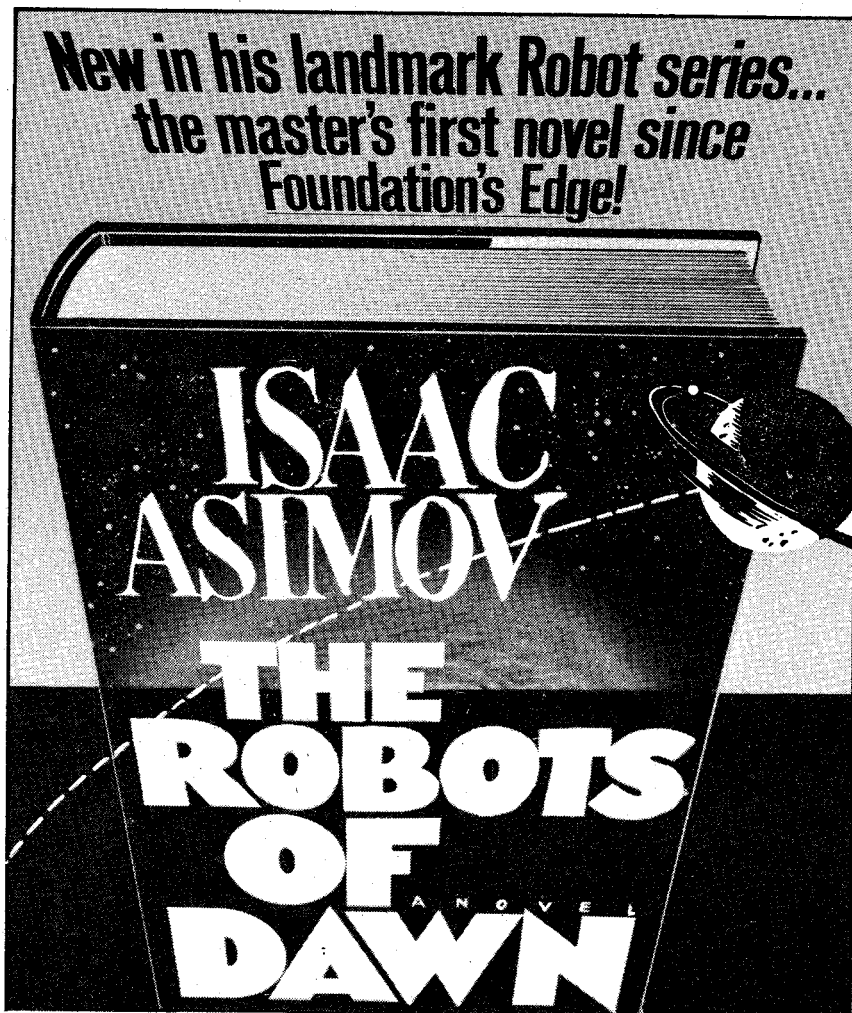

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Guest Editorial

BEYOND THE GLOBAL VILLAGE

Arthur C. Clarke

There is always something new to be learned from the past, and I would like to open with two anecdotes from the early days of the telephone.* They illustrate perfectly how difficult—if not impossible—it is to anticipate the social impact of a truly revolutionary invention.

Though the first story is now rather famous—and I must apologise to those who've heard it before—I hope it's unfamiliar to most of you.

When news of Alexander Graham Bell's invention reached the United Kingdom, the chief engineer of the British Post Office failed to be impressed. "The Americans," he said loftily, "have need of the telephone—but we do not. We have plenty of messenger boys."

The second story I heard only quite recently, and in some ways it's even more instructive. In contrast to the British engineer, the mayor of a certain American city was wildly enthusiastic. He thought that the telephone was a marvellous device, and ventured this stunning prediction. "I can see the

**Address originally delivered at the United Nations on World Communications Day, May 17, 1983.*

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time," he said solemnly, "*when every city will have one.*"

If, during the course of this talk, you think that I am getting a little two fanciful, please remember that mayor. . . .

We have now reached the stage when virtually anything we want to do in the field of communications is possible: the constraints are no longer technical, but economic, legal, or political. Thus if you want to transmit the *Encyclopaedia Britannica* around the world in one second, you can do so. But it may be a lot cheaper if you're prepared to wait a whole minute—and you must check with the *Britannica*'s lawyers first.

Yet while recognising and applauding all these marvels, I am only too well aware of present realities. In Sri Lanka, for example, a major problem is that the village postmaster may not even have the stamps he needs—to put on the telegrams that must be *mailed*, because copper-thieves have stolen the overhead wires. And Sri Lanka, compared to some countries, is rich. It has already imported over a hundred thousand TV sets and thousands of videotape recorders. That would have been unthinkable only a few years ago—but human beings need information and entertainment almost as much as they need food, and when an invention arrives which can provide both in unprecedented quantities, sooner or later everyone manages to find the money for it.

This is particularly true when the cost of the hardware drops tenfold every decade—look at the example of pocket calculators! So please don't dismiss my future because no-one can afford it. The human race can afford anything it really needs—and improvements in communications often pay for themselves more swiftly than improvements in transportation. A developing country may sometimes be better advised to build telephone links than roads to its outlying provinces, if it has to make the choice.

Let me now focus on the only aspect of the communications revolution which I am at all competent to discuss, and which has profoundly affected my own lifestyle—not to mention that of millions of other people.

Until 1976, making an international telephone call from my home in Sri Lanka was an exercise in frustration that might last several days. Now, thanks to the Indian Ocean satellite, I can get through to London or New York in slightly less time than it takes to dial the thirteen-digit number. As a result, I can now live exactly where I please, and have cut my travelling to a fraction of its former value.

Comsats have created a world without distance, and have already had a profound effect on international business, news-gathering, and tourism—one of the most important industries of many developing countries. Yet their real impact has scarcely begun: before the end of this century—only seventeen years ahead!—they will have transformed the planet, sweeping away much that is evil and, unfortunately, not a few things that are good.

The slogan "A telephone in every village" should remind you of that American mayor, so don't laugh. I believe it is a realistic and (equally important!) desirable goal by the year 2000. It can be achieved now that mil-

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lions of kilometres of increasingly scarce copper wire can be replaced by a handful of satellites in stationary orbit. And on the ground we need a simple, rugged handset and solar-powered transceiver plus antenna, which could be mass-produced for tens rather than hundreds of dollars.

At this point I would like to borrow an expression from the military: "force multipliers." A force multiplier is a device which increases, often by a very large factor, the effectiveness of an existing system. For example, it may take fifty old-fashioned bombs to knock out a bridge. But if you give them TV guidance, you will need only one or two, though the explosive power per bomb remains exactly the same.

I suggest that the "Telephone in the Village" would be one of the most effective "force multipliers" in history, because of its implications for health, animal husbandry, weather forecasts, market advice, social integration, and human welfare. Each installation would probably pay for itself, in hard cash, within a few months. I would like to see a cost-effectiveness study of rural satellite telephone systems for Africa, Asia, and South America. But the financial benefits, important though they undoubtedly would be, might yet be insignificant compared with the social ones. Unlike its military equivalent, *this* force multiplier would increase the health, wealth, and happiness of mankind.

However, long before the global network of *fixed* telephones is established, there will be a parallel development which will eventually bypass it completely—though perhaps not until well into the next century. It is starting now, with cellular networks, portable radiophones, and paging devices, and will lead ultimately to our old science fiction friend, the wristwatch telephone.

Before we reach that, there will be an intermediate stage. During the coming decade, more and more businessmen, well-heeled tourists, and virtually *all* newspersons will be carrying attache case-sized units that will permit direct two-way communication with their homes or offices, *via* the most convenient satellite. These will provide voice, telex, and video facilities (still photos and, for those who need it, live TV coverage). As these units become cheaper, smaller and more universal, they will make travellers *totally independent of national communications systems.*

The implications of this are profound—and not only to media newsgatherers who will no longer be at the mercy of censors or inefficient (sometimes non-existent) postal and telegraph services. It means the end of closed societies and will lead ultimately—to repeat a phrase I heard Arnold Toynbee use forty years ago—to the Unification of the World.

You may think this is a naive prediction, because many countries wouldn't let such subversive machines across their borders. But they would *have no choice;* the alternative would be economic suicide, because very soon they would get no tourists, and no businessmen offering foreign currency. They'd get only spies, who would have no trou-

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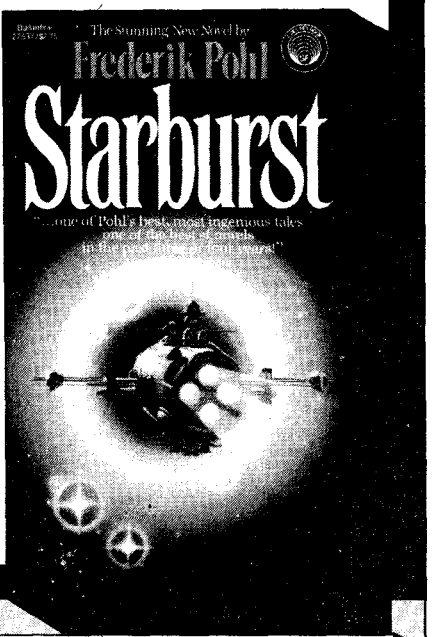
Starburst

by Frederik Pohl

Dr. Dieter von Knefhausen had chosen a group of the best and brightest: these scientists *cum* astronauts were to explore the planet Alpha-Aleph and then return—or so they thought. But von Knefhausen knew otherwise—for there was no planet, no place to go...and no place from which to return!



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ble at all concealing the powerful new tools of their ancient trade.

What I am saying, in fact, is that the debate about the "Free Flow of Information" which has been going on for so many years will soon be settled—by engineers, not politicians. (Just as physicists, not generals, have now determined the nature of war.)

Consider what this means. No government will be able to conceal, at least for very long, evidence of crimes or atrocities—even from its own people. The very existence of the myriads of new information channels, operating in real time and across all frontiers, will be a powerful influence for civilised behaviour. If you are arranging a massacre, it will be useless to shoot the cameraman who has so inconveniently appeared on the scene. His pictures will already be safe in the studio five thousand kilometres away; and his final image may hang you.

Many governments will not be at all happy about this, but in the long run everyone will benefit. Exposures of scandals or political abuses—especially by visiting TV teams who go home and make rude documentaries—can be painful, but also very valuable. Many a ruler might still be in power today, or even alive, had he known what was really happening in his own country. A wise statesman once said: "A free press can give you hell, but it can save your skin." That is even more true of TV reporting—which, thanks to satellites, will soon be instantaneous and ubiquitous. Let us hope that it will also be responsible. Considering what has often happened in the past, optimism here may well be tempered with concern.

A quarter of a century ago, the transistor began to sweep across the world, starting a communications revolution in all countries, developed and undeveloped. It is a continuing revolution—a steady explosion, if I may be permitted the paradox—and it is nowhere completed. Indeed, it will accelerate when the cheap solar-powered radio eliminates dependence on batteries, so expensive and difficult to obtain in remote places.

The transistor radio has already brought news, information, and entertainment to millions who would otherwise have been almost totally deprived of so much that we take for granted. But TV is a far more powerful medium, and thanks to the new generation of satellites, its time has now arrived.

I hesitate to add to the megawords—if not gigawords—written about educational TV and direct broadcast satellites. But despite all this verbiage, there still seem to be a number of points that are not generally understood, perhaps because of the human dislike for facing awkward truths.

Attempts have been made, in some quarters, to regulate or even prohibit direct broadcasting from space. But *radio waves do not recognise frontiers*, and *it is totally impossible to prevent spill-over*. Even if country A did its best to keep its programmes from reaching its neighbour B, it could not always succeed. During the 1976 Satellite Instructional Television Experiment (SITE), the beam from the ATS 6 satellite was deliberately slanted towards India to

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give maximum signal strength there. Yet good images were still received in England, a quarter of the way around the globe!

Those who would promulgate what might be called "permission to receive" laws remind me of the fabled American state legislature which, back in the last century, ruled that the value of pi is exactly 3, as given in the Old Testament. (Alas, this delightful story isn't true: but it can be matched by similar absurdities at this very moment.)

In any event, technology has once again superseded politics. All over the United States, the Caribbean, and South America, small "receive only" dishes are sprouting like mushrooms, tuning in to the hundreds of satellite channels now available—and there's little that anyone can do about it, without spending a lot of money on scramblers and encrypting devices which may sometimes defeat their own purpose.

In Sri Lanka, radio amateurs with quite simple equipment have been receiving excellent pictures from the Soviet Union's powerful EKRAN satellites; thanks to these, we were able to enjoy the Moscow Olympics. I would like to express my gratitude to the Russian engineers for their continuing large-scale demonstration, over the whole of Asia, that the politicians are not only talking technical nonsense, but are ignoring their own proclamations.

They are not the only ones guilty of hypocrisy, as my good friend Dr. Yash Pal pointed out in these words several years ago:

"In the drawing rooms of large cities you meet many people who are concerned with the damage that one is going to cause to the integrity of rural India by exposing her to the world outside. After they have lectured you about the dangers of corrupting this innocent, beautiful mass of humanity, they usually turn around and add: 'Well, now that we have a satellite, when are we going to see some American programmes?' Of course, they themselves are immune to cultural domination or foreign influences. . . ."

When I quoted this at the 1981 UNESCO IPDC meeting in Paris, I added these words:

"I am afraid that cocktail-party intellectuals are the same everywhere. Because we frequently suffer from the scourge of information pollution, we find it hard to imagine its even deadlier opposite—*information starvation*. I get very annoyed when I hear arguments, usually from those who have been educated beyond their intelligence, about the virtues of keeping happy, backward peoples in ignorance. Such an attitude seems like that of a fat man preaching the benefits of fasting to a starving beggar.

"And I am not impressed by the attacks on television because of the truly dreadful programmes it often carries. Every TV programme has some educational content; the cathode tube is a window on the world—indeed, on many worlds. Often it is a very murky window, but I have slowly come to the conclusion that, on balance, even bad TV is better than no TV at all."

Many will disagree with this—and I sympathise with them. Electronic cul-

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tural imperialism will sweep away much that is good, as well as much that is bad. Yet it will only accelerate changes which were in any case inevitable; and on the credit side, the new media will preserve for future generations the customs, performing arts, and ceremonies of our time, in a way that was never possible in any earlier age.

Of course, there are a great many of our present customs which should *not* be preserved, except as warnings to future generations. Slavery, torture, racial and religious persecution, treatment of women as chattel, mutilation of children because of ancient superstitions, cruelty to animals—the list is endless, and no country can proclaim total innocence. But looming monstrously above all these evils is the ever-present threat of nuclear war.

I wish I could claim that improved communications would lead to peace, but the matter is not as simple as that. Excellent communications—even a common language!—have not brought peace to Northern Ireland, to give but one of many possible examples. Nevertheless, good communications of every type, and at all levels, are essential if we are ever to establish peace on this planet. As the mathematicians would say—they are necessary, but not sufficient.

Perhaps an additional necessity may be the International Monitoring Satellite system, proposed by the French government in 1978 and now the subject of a UN report which is being reissued this month [May 1983] at the request of the General Assembly. I refer you to this 123-page document (E.83.IX.3—*The Implications of Establishing an International Satellite Monitoring Agency*) for details; all I need say here is that it considers the potential benefits to mankind if *all* nations had access to the orbital reconnaissance information now available only to the United States and the Soviet Union. Roughly speaking, these powers now have the ability to observe any piece of military equipment larger than a rifle, in clear weather during daylight; and to track surface vessels at *any* time.

You will not be surprised to know that both the U.S. and the U.S.S.R. agree in opposing any scheme that will break their joint monopoly on strategic information, and one of their main criticisms of the Monitoring Satellite System is all too valid. Even if it were established, could it *really* work during a period of international crisis—if more than a hundred nations each had a finger on the ERASE button of the computer that stored the disputed information?

I have a modest proposal. The French, who suggested the IMS in the first place, are about to launch an Earth Resources Satellite (SPOT) whose capabilities in some respects approach those of military reconnaissance satellites. Its images will be available, on a purely commercial basis, to anyone who wants to buy them, at the rate of about thirty cents per square kilometre.

Suppose a small consortium of traditionally neutral countries set up an image-processing and intelligence-evaluating organisation. (Sweden, with its Stockholm International Peace Research Institute, is an obvious choice; one

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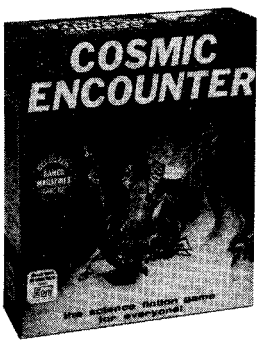

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could add Switzerland and the Netherlands—perhaps that would be enough!)

It would contract with the SPOTimage company for satellite information, and analyse it for any country which considered itself threatened—on condition that the results were made available to the whole world.

This would only be a beginning, of course; the next step would be to purchase a SUPERSPOT with much higher resolution. I leave others to work out the details, but none of the problems seems insuperable. And with all respect to the distinguished organisation in whose premises we are assembled, three or four nations could have the system running smoothly—*years* before 155 could even agree on its desirability.

Such an institute could well adopt, without irony, the ambiguous slogan of the U.S. Strategic Air Command: "Peace is our profession." And though I wish I could offer the facilities of the Centre for Modern Technologies which we hope to set up in Sri Lanka, I fear that it will be quite a while before it would possess the necessary skills and equipment. Yet nothing would be more appropriate, for here in this very building I once heard Prime Minister Sirimavo Bandaranaike make her proposal for an Indian Ocean Zone of Peace. We might take at least one small step towards that goal, if everything moving on the face of the Indian Ocean was clearly labelled for all the world to see.

I would like to end this survey of our telecommunications future with one of the most remarkable predictions ever made. In the closing decade of the 19th century an electrical engineer, W.E. Ayrton, was lecturing at London's Imperial Institute about the most modern

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of communications devices, the submarine telegraph cable. He ended with what must, to all his listeners, have seemed the wildest fantasy:

"There is no doubt that the day will come, maybe when you and I are forgotten, when copper wires, gutta-percha coverings, and iron sheathings will be relegated to the Museum of Antiquities. Then, when a person wants to telegraph to a friend, he knows not where, he will call in an electro-magnetic voice, which will be heard loud by him who has the electro-magnetic ear, but will be silent to everyone else. He will call 'Where are you?' and the reply will come 'I am at the bottom of the coal-mine' or 'Crossing the Andes' or 'In the middle of the Pacific'; or perhaps no reply will come at all, and he may then conclude that his friend is dead."

This truly astonishing prophecy was made in 1897, long before anyone could imagine how it might be fulfilled. A century later, by 1997, it will be on the verge of achievement, because the wristwatch telephone will be coming into general use. And if you still believe that such a device is unlikely, ask yourself this question: Who could have imagined the personal watch, back in the Middle Ages—when the only clocks were clanking, room-sized mechanisms, the pride and joy of a few cathedrals?

For that matter, many of you carry on your wrists miracles of electronics that would have been beyond belief even twenty years ago. The symbols that flicker across those digital displays now merely give time and date. When the zeroes flash up at the end of the century, they will do far more than that. They will give you direct access to most of the human race, through the invisible networks girdling our planet.

The long-heralded Global Village is almost upon us, but it will last for only a flickering moment in the history of Mankind. Before we even realise that it has come, it will be superseded—by the Global Family. ■

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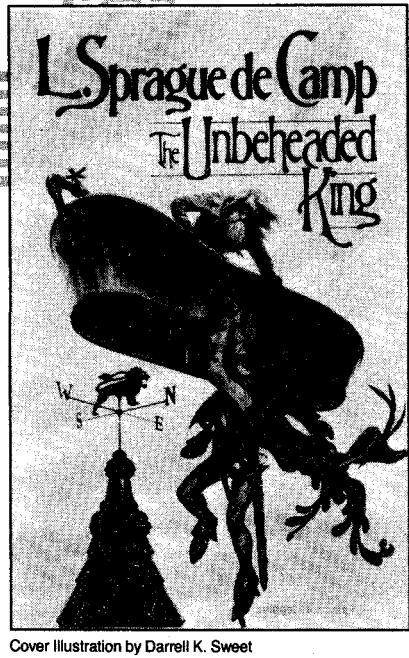

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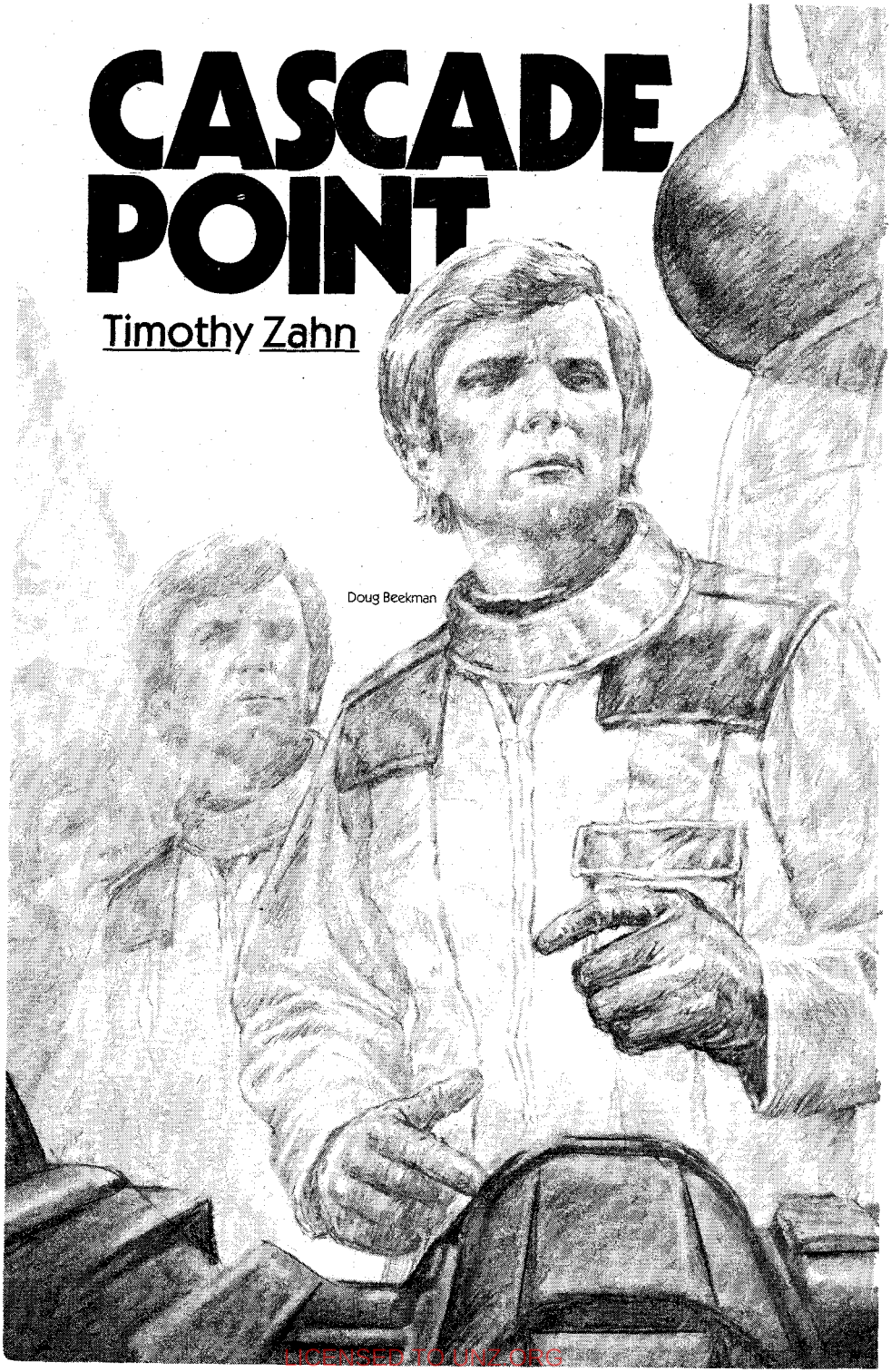
Timothy Zahn



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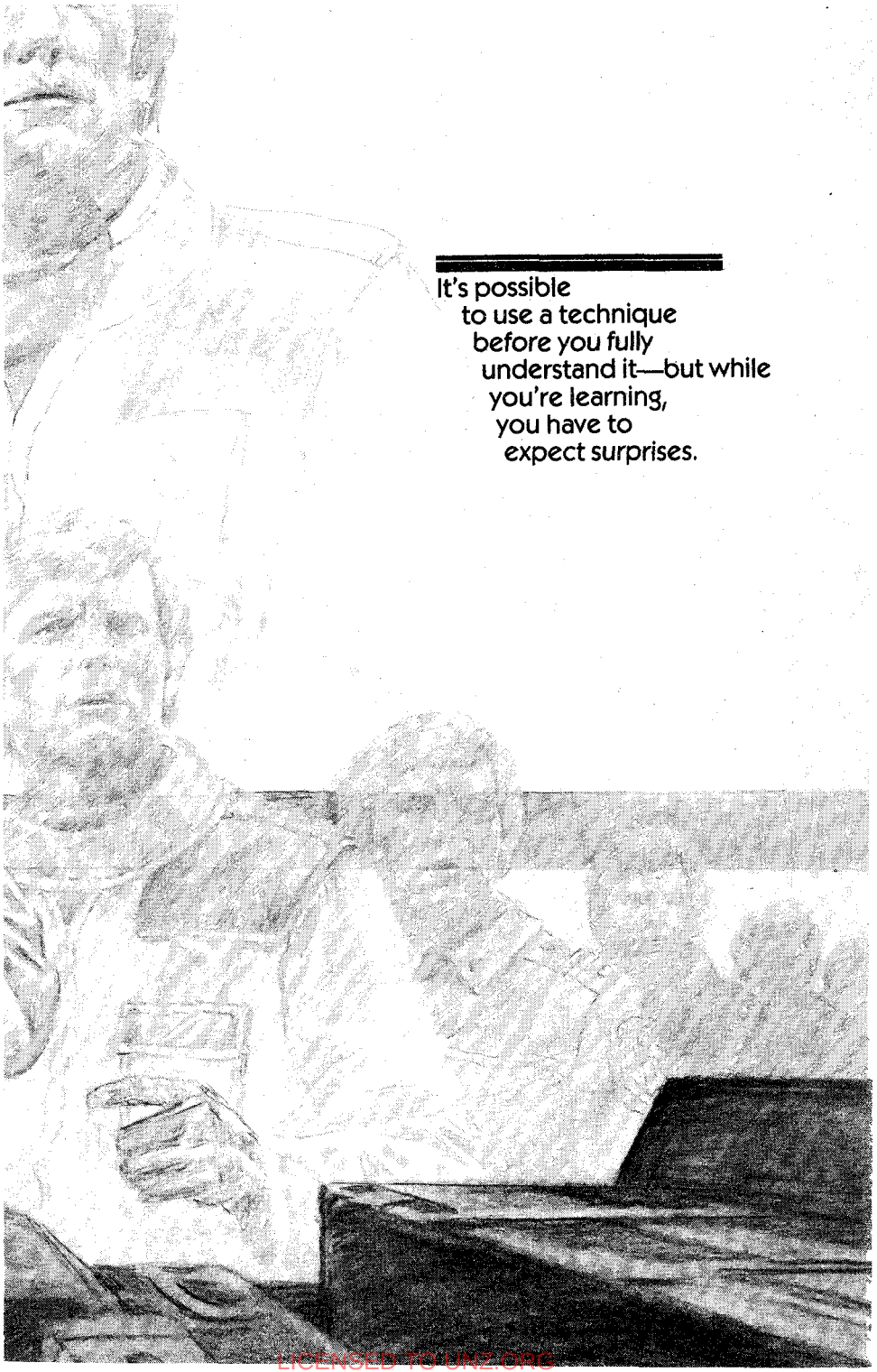

It's possible
to use a technique
before you fully
understand it—but while
you're learning,
you have to
expect surprises.

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In retrospect, I suppose I should have realized my number had come up on the universe's list right from the very start, right from the moment it became clear that I was going to be stuck with the job of welcoming the *Aura Dancer*'s latest batch of passengers aboard. Still, I suppose it's just as well it was me and not Tobbar who let Rik Bradley and his psychiatrist onto my ship. There are some things that a captain should have no one to blame for but himself, and this was definitely in that category.

Right away I suppose that generates a lot of false impressions. A star liner captain, resplendent in white and gold, smiling toothily at elegantly dressed men and women as the ramp carries them through the polished entry portal—forget all of that. A tramp starmer isn't polished anywhere it doesn't absolutely have to be, the captain is lucky if he's got a clean jumpsuit—let alone some pseudo-military Christmas tree frippery—and the passengers we get are the steerage of the star-traveling community. And look it.

Don't get me wrong; I have nothing against passengers aboard my ship. As a matter of fact, putting extra cabins in the *Dancer* had been my idea to start with, and they'd all too often made the difference between profit and loss in our always marginal business. But one of the reasons I had gone into space in the first place was to avoid having to make small talk with strangers, and I would rather solo through four cascade points in a row than spend those agonizing minutes at the entry portal. In this case, though, I had no choice. Tobbar, our master of drivel—and thus the man unofficially in charge of civilian small talk—was up to his elbows in grease and balky hydraulics; and my second choice, Alana Keal, had finally gotten through to an equally balky tower controller who wanted to bump us ten ships back in the lift pattern. Which left exactly one person—me—because there was no one else *I'd* trust with giving a good first impression of my ship to paying customers. And so I was the one standing on the ramp when Bradley and his eleven fellow passengers hove into sight.

They ranged from semi-scruffy to respectable-but-not-rich—about par for the *Dancer*—but even in such a diverse group Bradley stood out like a red light on the status board. He was reasonably good-looking, reasonably average in height and build; but there was something in the way he walked that immediately caught my attention. Sort of a cross between nervous fear and something I couldn't help but identify as swagger. The mix was so good that it was several seconds before it occurred to me how mutually contradictory the two impressions were, and the realization left me feeling more uncomfortable than I already did.

Bradley was eighth in line, with the result that my first seven greetings were carried out without a lot of attention from my conscious mind—which I'm sure only helped. Even standing still, I quickly discovered, Bradley's strangeness made itself apparent, both in his posture and also in his face and eyes. Especially his eyes.

Finally it was his turn at the head of the line. "Good morning, sir," I said, shaking his hand. "I'm Captain Pall Durriken. Welcome aboard."

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"Thank you." His voice was bravely uncertain, the sort my mother used to describe as mousy. His eyes flicked the length of the *Dancer*, darted once into the portal, and returned to my face. "How often do ships like this crash?" he asked.

I hadn't expected any questions quite so blunt, but the fact that it was outside the realm of small talk made it easy to handle. "Hardly ever," I told him. "The last published figures showed a death rate of less than one per million passengers. You're more likely to be hit by a chunk of roof tile off the tower over there."

He actually cringed, turning halfway around to look at the tower. I hadn't dreamed he would take my comment so seriously, but before I could get my mouth working the man behind Bradley clapped a reassuring hand on his shoulder. "It's all right, Rik—nothing's going to hurt you. Really. This is a good ship, and we're going to be perfectly safe aboard her."

Bradley slowly straightened, and the other man shifted his attention to me. "I'm Dr. Hammerfeld Lanton, Captain," he said, extending his hand. "This is Rik Bradley. We're traveling in adjoining cabins."

"Of course," I said, nodding as if I'd already known that. In reality I hadn't had time to check out the passenger lists and assignments, but I could trust Leeds to have set things up properly. "Are you a doctor of medicine, sir?"

"In a way," Lanton said. "I'm a psychiatrist."

"Ah," I said, and managed two or three equally brilliant conversational gems before the two of them moved on. The last three passengers I dispatched with similar polish, and when everyone was inside I sealed the portal and headed for the bridge.

Alana had finished her dickering with the tower and was running the pre-lift computer check when I arrived. "What's the verdict?" I asked as I slid into my chair and keyed for helm check.

"We've still got our lift slot," she said. "That's conditional on Matope getting the elevon system working within the next half-hour, of course."

"Idiots," I muttered. The elevons wouldn't be needed until we arrived at Taimyr some six weeks from now, and Matope could practically rebuild them from scratch in that amount of time. To insist they be in prime condition before we could lift was unreasonable even for bureaucrats.

"Oh, there's no problem—Tobbar reported they were closing things up a few minutes ago. They'll put it through its paces, it'll work perfectly, they'll transmit the readout, and that'll be that." She cleared her throat. "Incidentally . . . are you aware we've got a skull-diver and his patient aboard?"

"Yes; I met—*patient?*" I interrupted myself as the last part of her sentence registered. "Who?"

"Name's Bradley," she said. "No further data on him, but apparently he and this Lanton character had a fair amount of electronic and medical stuff delivered to their cabins."

A small shiver ran up my back as I remembered Bradley's face. No wonder he'd struck me as strange. "No mention at all of what's wrong—of why Bradley needs a psychiatrist?"

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"Nothing. But it can't be anything serious." The test board bleeped, and Alana paused to peer at the results. Apparently satisfied, she keyed in the next test on the check list. "The Swedish Psychiatric Institute seems to be funding the trip, and they presumably know the regulations about notifying us of potential health risks."

"Um." On the other hand, a small voice whispered in my ear, if there was some problem with Bradley that made him marginal for space certification, they were more likely to get away with slipping him aboard a tramp than a liner. "Maybe I should give them a call, anyway. Unless you'd like to?"

I glanced over in time to see her face go stony. "No, thank you," she said firmly.

"Right." I felt ashamed of the comment, not really having meant it the way it had come out. All of us had our own reasons for being where we were; Alana's was an overdose of third-degree emotional burns. She was the type who'd seemingly been born to nurse broken wings and bruised souls, the type who by necessity kept her own heart in full view of both friends and passersby. Eventually, I gathered, one too many of her mended souls had torn out the emotional IVs she'd set up and flown off without so much as a backward glance, and she had renounced the whole business and run off to space. Ice to Europa, I'd thought once; there were enough broken wings out here for a whole shipload of Florence Nightingales. But what I'd expected to be a short vacation for her had become four years' worth of armor plate over her emotions, until I wasn't sure she even knew anymore how to care for people. The last thing in the universe she would be interested in doing would be getting involved in any way with Bradley's problems. "Is all the cargo aboard now?" I asked, to change the subject.

"Yes, and Wilkinson certifies it's properly stowed."

"Good." I got to my feet. "I guess I'll make a quick spot survey of the ship, if you can handle things here."

"Go ahead," she said, not bothering to look up. Nodding anyway, I left.

I stopped first at the service shafts where Matope and Tobbar were just starting their elevon tests, staying long enough to satisfy myself the resulting data were adequate to please even the tower's bit-pickers. Then it was to each of the cargo holds to double-check Wilkinson's stowing arrangement, to the passenger area to make sure all their luggage had been properly brought on board, to the computer room to look into a reported malfunction—a false alarm, fortunately—and finally back to the bridge for the lift itself. Somehow, in all the running around, I never got around to calling Sweden. Not, as I found out later, that it would have done me any good.

We lifted right on schedule, shifting from the launch field's grav booster to ramjet at ten kilometers and kicking in the fusion drive as soon as it was legal to do so. Six hours later we were past Luna's orbit and ready for the first cascade maneuver.

Leeds checked in first, reporting officially that the proper number of dosages had been drawn from the sleeper cabinet and were being distributed to the

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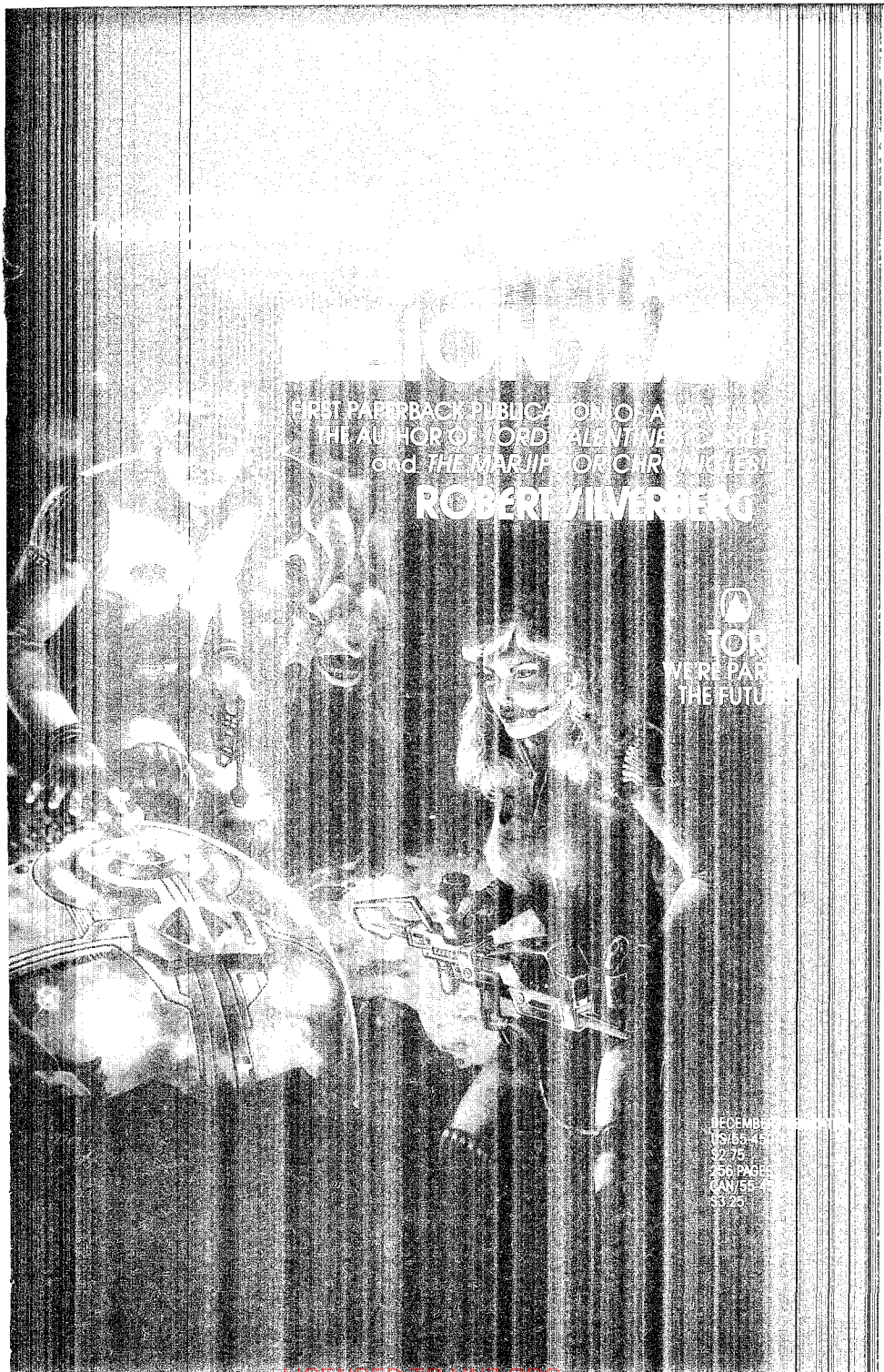

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passengers. Pascal gave the okay from the computer room, Matope from the engine room, and Sarojis from the small chamber housing the field generator itself. I had just pulled a hard copy of the computer's course instructions when Leeds called back. "Captain, I'm in Dr. Lanton's cabin," he said without preamble. "Both he and Mr. Bradley refuse to take their sleepers."

Alana turned at that, and I could read my own thought in her face: Lanton and Bradley had to be nuts. "Has Dr. Epstein explained the reasons behind the procedure?" I asked carefully, mindful of both my responsibilities and my limits here.

"Yes, I have," Kate Epstein's clear soprano came. "Dr. Lanton says that his work requires both of them to stay awake through the cascade point."

"Work? What sort of work?"

A pause, and Lanton's voice replaced Kate's. "Captain, this is Dr. Lanton. Rik and I are involved in an experimental type of therapy here. The personal details are confidential, but I assure you that it presents no danger either to us or to you."

Therapy. Great. I could feel anger starting to churn in my gut at Lanton's casual arrogance in neglecting to inform me ahead of time that he had more than transport in mind for my ship. By all rights I should freeze the countdown and sit Lanton down in a corner somewhere until *I* was convinced everything was as safe as he said. But time was money in this business; and if Lanton was glossing things over he could probably do so in finer detail than I could catch him on, anyway. "Mr. Bradley?" I called. "You agree to pass up your sleeper, as well?"

"Yes, sir," came the mousy voice.

"All right. Dr. Epstein, you and Mr. Leeds can go ahead and finish your rounds."

"Well," Alana said as I flipped off the intercom, "at least if something goes wrong the record will clear us of any fault at the inquest."

"You're a genuine ray of sunshine," I told her sourly. "What else could I have done?"

"Raked Lanton over the coals for some information. We're at least entitled to know what's going on."

"Oh, we'll find out, all right. As soon as we're through the point I'm going to haul Lanton up here for a long, cozy chat." I checked the readouts. Cascade point in seventeen minutes. "Look, you might as well go to your cabin and hit the sack. I know it's your turn, but you were up late with that spare parts delivery and you're due for some down time."

She hesitated; wanting to accept, no doubt, but slowed by considerations of duty. "Well . . . all right. I'm taking the next one, then. I don't know, though; maybe you shouldn't be up here alone. In case Lanton's miscalculated."

"You mean if Bradley goes berserk or something?" That thought had been lurking in my mind, too, though it sounded rather ridiculous when spoken out loud. Still . . . "I can lower the pressure in the passenger deck corridor to half an atmosphere. That'll be enough to lock the doors without triggering any vacuum alarms."

"Leaves Lanton on his own in case

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of trouble . . . but I suppose that's okay."

"He's the one who's so sure it's safe. Go on, now—get out of here."

She nodded and headed for the door. She paused there, though, her hand resting on the release. "Don't just haul Lanton away from Bradley when you want to talk to him," she called back over her shoulder. "Try to run into him in the lounge or somewhere instead when he's already alone. It might be hard on Bradley to know you two were off somewhere together talking about him." She slapped the release, almost viciously, and was gone.

I stared after her for a long minute, wondering if I'd actually seen a crack in that heavy armorplate. The bleep of the intercom brought me back to the task at hand, Kate telling me the passengers were all down and that she, Leeds, and Wilkinson had taken their own sleepers. One by one the other six crewers also checked in. Within ten minutes they would be asleep, and I would be in sole charge of my ship.

Twelve minutes to go. Even with the *Dancer*'s old manual setup there was little that needed to be done. I laid the hard copy of the computer's instructions where it would be legible but not in the way, shut down all the external sensors and control surfaces, and put the computer and other electronic equipment into neutral/standby mode. The artificial gravity I left on; I'd tried a cascade point without it once and would never do so again. Then I waited, trying not to think of what was coming . . . and at the appropriate time I lifted the safety cover and twisted the field generator control knob.

And suddenly there were five of us in the room.

I will never understand how the first person to test the Colloton Drive ever made it past this point. The images silently surrounding me a bare arm's length away were life-size, lifelike, and —at first glance, anyway—as solid as the panels and chairs they seemed to have displaced. It took a careful look to realize they were actually slightly transparent, like some kind of colored glass, and a little experimentation at that point would show they had less substance than air. They were nothing but ghosts, specters straight out of childhood's scariest stories. Which merely added to the discomfort . . . because all of them were me.

Five seconds later the second set of images appeared, perfectly aligned with the first. After that they came more and more quickly, as the spacing between them similarly decreased, forming an ever-expanding horizontal cross with me at the center. I watched—forced myself to watch—knew I *had* to watch —as the lines continued to lengthen, watched until they were so long that I could no longer discern whether any more were being added.

I took a long, shuddering breath —peripherally aware that the images nearest me were doing the same —and wiped a shaking hand across my forehead. *You don't have to look*, I told myself, eyes rigidly fixed on the back of the image in front of me. *You've seen it all before. What's the point?* But I'd fought this fight before, and I knew in advance I would lose. There was indeed no more point to it than there was to pressing a bruise, but it held an equal

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degree of compulsion. Bracing myself, I turned my head and gazed down the line of images strung out to my left.

The arm-chair philosophers may still quibble over what the cascade point images "really" are, but those of us who fly the small ships figured it out long ago. The Colloton field puts us into a different type of space, possibly an entire universe worth of it—that much is established fact. Somehow this space links us into a set of alternate realities, universes that might have been if things had gone differently . . . and what I was therefore seeing around me were images of what I would be doing in each of those universes.

Sure, the theory has problems. Obviously, I should generate a separate pseudo-reality every time I choose ham instead of turkey for lunch, and just as obviously such trivial changes don't make it into the pattern. Only the four images closest to me are ever exactly my doubles; even the next ones in line are noticeably if subtly different. But it's not a matter of subconscious suggestion, either. Too many of the images are . . . unexpected . . . for that.

It was no great feat to locate the images I particularly needed to see: the white-and-gold liner captain's uniforms stood out brilliantly among the more dingy jumpsuits and coveralls on either side. Liner captain. In charge of a fully equipped, fully modernized ship; treated with the respect and admiration such a position brought. It could have been —*should* have been. And to make things worse, I knew the precise decision that had lost it to me.

It had been eight years now since the uniforms had appeared among my cascade images; ten since the day I'd thrown Lord Hendrik's son off the bridge of the training ship and simultaneously guaranteed myself a blackballing with every major company in the business. Could I have handled the situation differently? Probably. Should I have? Given the state of the art then, no. A man who, after three training missions, still went borderline claustrophobic every time he had to stay awake through a cascade point had no business aboard a ship, let alone on its bridge. Hendrik might have forgiven me once he thought things through. The kid, who was forced into a ground position with the firm, never did. Eventually, of course, he took over the business.

I had no way of knowing that four years later the Aker-Ming Autotorque would eliminate the need for *anyone* to stay awake through cascade maneuvers. I doubt seriously the kid appreciated the irony of it all.

In the eight years since the liner captain uniforms had appeared they had been gradually moving away from me along all four arms of the cross. Five more years, I estimated, and they would be far enough down the line to disappear into the mass of images crowded together out there. Whether my reaction to that event would be relief or sadness I didn't yet know, but there was no doubt in my mind that it would in some way be the end of a chapter in my life. I gazed at the figures for another minute . . . and then, with my ritual squeezing of the bruise accomplished, I let my eyes drift up and down the rest of the line.

They were unremarkable, for the most part: minor variations in my ap-

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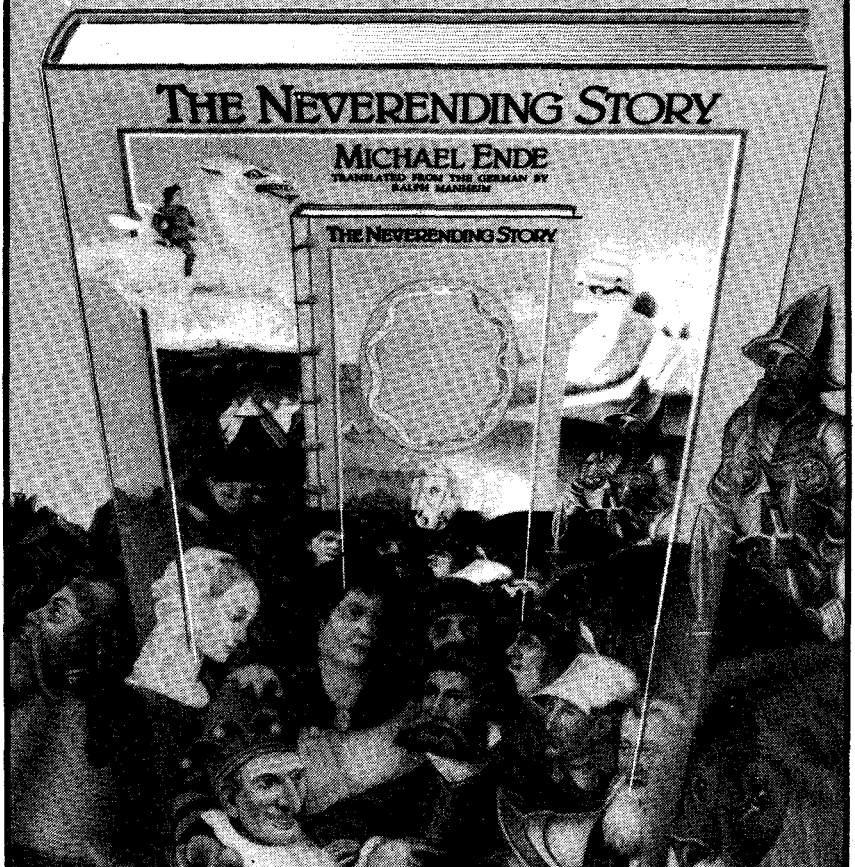

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DOUBLEDAY

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pearance or clothing. The handful that had once showed me in some non-spacing job had long since vanished toward infinity; I'd been out here a long time. Perhaps too long . . . a thought the half-dozen or so gaps in each arm of the pattern underlined with unnecessary force. I'd told Bradley that ships like the *Dancer* rarely crashed, a perfectly true statement; but what I hadn't mentioned was that the chances of simply disappearing en route were something rather higher. None of us liked to think about that, especially during critical operations like cascade point maneuvers. But the gaps in the image pattern were a continual reminder that people still died in space. In six possible realities, apparently, I'd made a decision that killed me.

Taking another deep breath, I forced all of that as far from my mind as I could and activated the *Dancer*'s flywheel.

Even on the bridge the hum was audible as the massive chunk of metal began to spin. A minute later it had reached its top speed . . . and the entire ship's counterrotation began to register on the gyroscope set behind glass in the ceiling above my head. The device looked out of place, a decided anachronism among the modern instruments, control circuits, and readouts filling the bridge. But it was the only way a ship our size could find its way safely through a cascade point. The enhanced electron tunneling effect that fouled up electronic instrument performance was well understood; what was still needed was a way to predict the precise effect a given cascade point rotation would generate. Without such predictability, readings couldn't even be given adjustment factors. Cascade navigation thus had to fall back on gross electrical and purely mechanical systems: flywheel, physical gyroscope, simple on-off controls, and a non-electronic decision-maker. Me.

Slowly, the long needle above me crept around its dial. I watched its reflection carefully in the magnifying mirror, a system that allowed me to see the indicator without having to break my neck looking up over my shoulder. Around me, the cascade images did their own slow dance, a strange kaleidoscopic thing that moved the images and gaps around within each branch of the cross, while the branches themselves remained stationary relative to me. The effect was unexplained; but then, Colloton field theory left a lot of things unexplained. Mathematically, the basic idea was relatively straightforward: the space we were in right now could be described by a type of bilinear conformal mapping—specifically, a conjugate inversion that maps lines into circles. From that point it was all downhill, the details tangling into a soup of singularities, branch points, and confluent Riemann surfaces; but what it all eventually boiled down to was that a yaw rotation of the ship here would become a linear translation when I shut down the field generator and we reentered normal space. The *Dancer*'s rotation was coming up on two degrees now, which for the particular configuration we were in meant we were already about half a light-year closer to our destination. Another—I checked the print-out—one point three six and I would shut down the flywheel, letting the *Dancer*'s momentum carry her an extra point two degree for a grand total of eight light-years.

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The needle crept to the mark, and I threw the flywheel switch, simultaneously giving my full attention over to the gyro. Theoretically, over- or undershooting the mark could be corrected during the next cascade point—or by fiddling the flywheel back and forth now—but it was simpler not to have to correct at all. The need to make sure we were stationary was another matter entirely; if the *Dancer* were still rotating when I threw the field switch we would wind up strung out along a million kilometers or more of space. I thought of the gaps in my cascade image pattern and shivered.

But that was all the closer death was going to get to me, at least this time. The delicately balanced spin lock worked exactly as it was supposed to, freezing the field switch in place until the ship's rotation was as close to zero as made no difference. I shut off the field and watched my duplicates disappear in reverse order, waiting until the last four vanished before confirming the stars were once again visible through the bridge's tiny viewport. I sighed; and fighting the black depression that always seized me at this point, I turned the *Dancer*'s systems back on and set the computer to figuring our exact position. Someday, I thought, I'd be able to afford to buy Aker-Ming Autotorques and never, *never* have to go through this again.

And someday I'd swim the Pacific Ocean, too.

Slumping back in my chair, I waited for the computer to finish its job and allowed the tears to flow.

Crying, for me, has always been the simplest and fastest way of draining off tension, and I've always felt a little sorry for men who weren't able to appreciate its advantages. This time was no exception, and I was feeling almost back to normal by the time the computer produced its location figures. I was still poring over them twenty minutes later when Alana returned to the bridge. "Another cascade point successfully hurdled, I see," she commented tiredly. "Hurray for our side."

"I thought you were supposed to be taking a real nap, not just a sleeper's worth," I growled at her over my shoulder.

"I woke up and decided to take a walk," she answered, her voice suddenly businesslike. "What's wrong?"

I handed her a print-out, pointed to the underlined numbers. "The gyroscope reading says we're theoretically dead on position. The stars say we're short."

"Wumph!" Frowning intently at the paper, she kicked around the other chair and sat down. "Twenty light-days. That's what, twice the expected error for this point? Great. You double-checked everything, of course?"

"Triple-checked. The computer confirmed the gyro reading, and the astrogate program's got positive ident on twenty stars. Margin of error's no greater than ten light-minutes on either of those."

"Yeah." She eyed me over the pages. "Anything funny in the cargo?"

I gestured to the manifest in front of me. "We've got three boxes of technical equipment that include Ming metal," I said. "All three are in the shield. I checked that before we lifted."

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"Maybe the shield's sprung a leak," she suggested doubtfully.

"It's supposed to take a hell of a break before the stuff inside can affect cascade point configuration."

"I can go check if you'd like."

"No, don't bother. There's no rush now, and Wilkinson's had more experience with shield boxes. He can take a look when he wakes up. I'd rather you stay here and help me do a complete programming check. Unless you'd like to obey orders and go back to bed."

She smiled faintly. "No, thanks; I'll stay. Um . . . I could even start things alone if you'd like to go to the lounge for a while."

"I'm fine," I growled, irritated by the suggestion.

"I know," she said. "But Lanton was down there alone when I passed by on my way here."

I'd completely forgotten about Lanton and Bradley, and it took a couple of beats for me to catch on. Cross-examining a man in the middle of cascade depression wasn't a terrifically nice thing to do, but I wasn't feeling terrifically nice at the moment. "Start with the astrogate program," I told Alana, getting to my feet. "Give me a shout if you find anything."

Lanton was still alone in the lounge when I arrived. "Doctor," I nodded to him as I sat down in the chair across from his. "How are you feeling?" The question was more for politeness than information; the four empty glasses on the end table beside him and the half-full one in his hand showed how he'd chosen to deal with his depression. I'd learned long ago that crying was easier on the liver.

He managed a weak smile. "Better, Captain; much better. I was starting to think I was the only one left on the ship."

"You're not even the only one awake," I said. "The other passengers will probably be wandering in shortly — you people get a higher-dose sleeper than the crew takes."

He shook his head. "Lord, but that was weird. No wonder you want everyone to sleep through it. I can't remember the last time I felt this rotten."

"It'll pass," I assured him. "How did Mr. Bradley take it?"

"Oh, fine. Much better than I did, though he fell apart just as badly when it was over. I gave him a sedative—the coward's way out, but I wasn't up to more demanding therapy at the moment."

So Bradley wasn't going to be walking in on us any time soon. Good. "Speaking of therapy, Doctor, I think you owe me a little more information about what you're doing."

He nodded and took a swallow from his glass. "Beginning, I suppose, with what exactly Rik is suffering from?"

"That would be nice," I said, vaguely surprised at how civil I was being. Somehow, the sight of Lanton huddled miserably with his liquor had taken all the starch out of my fire-and-brimstone mood. Alana was clearly having a bad effect on me.

"Okay. Well, first and foremost, he is *not* in any way dangerous, either to himself or other people. He has no tendencies even remotely suicidal or homicidal. He's simply . . . permanently disoriented, I suppose, is one way to think of it. His personality seems to

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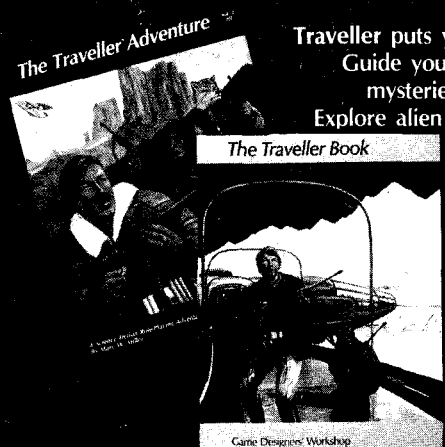

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slide around in strange ways, generating odd fluctuations in behavior and perception."

Explaining psychiatric concepts in layman's terms obviously wasn't Lanton's forte. "You mean he's schizophrenic? Or paranoid?" I added, remembering our launch field conversation.

"Yes and no. He shows some of the symptoms of both—along with those of five or six other maladies—but he doesn't demonstrate the proper biochemical syndrome for any known mental disease. He's a fascinating, scientifically annoying anomaly. I've got whole bubble-packs of data on him, taken over the past five years, and I'm convinced I'm teetering on the edge of a breakthrough. But I've already exhausted all the standard ways of probing a patient's subconscious, and I had to come up with something new." He gestured around him. "This is it."

"This is what? A new form of shock therapy?"

"No, no—you're missing the point. I'm studying Rik's cascade images."

I stared at him for a long moment. Then, getting to my feet, I went to the autobar and drew myself a lager. "With all due respect," I said as I sat down again, "I think you're out of your mind. First of all, the images aren't a product of the deep subconscious or whatever; they're reflections of universes that might have been."

"Perhaps. There *is* some argument about that." He held up a hand as I started to object. "But either way, you have to admit that your conscious or unconscious mind *must* have an influence on them. Invariably, the images that appear show the results of *major* decisions or events in one's life; never the plethora of insignificant choices we all make. Whether the subconscious is choosing among actual images or generating them by itself, it *is* involved with them and therefore can be studied through them."

He seemed to settle slightly in his chair, and I got the feeling this wasn't the first time he'd made that speech. "Even if I grant you all that," I said, "which I'm not sure I do, I think you're running an incredibly stupid risk that the cascade point effects will give Bradley a shove straight over the edge. They're hard enough on those of us who *haven't* got psychological problems—what am I telling you this for? *You* saw what it was like, damn it. The last thing I want on my ship is someone who's going to need either complete sedation or a restraint couch all the way to Taimyr!"

I stopped short, suddenly aware that my volume had been steadily increasing. "Sorry," I muttered, draining half of my lager. "Like I said, cascade points are hard on all of us."

He frowned. "What do you mean? You were asleep with everyone else, weren't you?"

"Somebody's got to be awake to handle the maneuver," I said.

"But . . . I thought there were autopilots for cascade points now."

"Sure—the Aker-Ming Autotorque. But they cost nearly twenty-two thousand apiece and have to be replaced every hundred cascade points or so. The big liners and freighters can afford luxuries like that; tramp starmers can't."

"I'm sorry—I didn't know." His expression suggested he was also sorry

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he hadn't investigated the matter more thoroughly before booking aboard the *Dancer*.

I'd seen that look on people before, and I always hated it. "Don't worry; you're perfectly safe. The manual method's been used for nearly two centuries, and my crew and I know what we're doing."

His mind was obviously still a half kilometer back. "But how can it be that expensive? I mean, Ming metal's an exotic alloy, sure, but it's only selenium with a little bit of rhenium, after all. You can buy psy-test equipment with Ming metal parts for a fraction of the cost you quoted."

"And we've got an entire box made of the stuff in our number one cargo hold," I countered. "But making a consistent-property rotation gauge is a good deal harder than rolling sheets or whatever. Anyway, you're evading my question. What are you going to do if Bradley can't take the strain?"

He shrugged, but I could see he didn't take the possibility seriously. "If worse comes to worse, I suppose I could let him sleep while I stayed awake to observe his images. They *do* show up even in your sleep, don't they?"

"So I've heard." I didn't add that I'd feel like a voyeur doing something like that. Psychiatrists, accustomed to poking into other people's minds, clearly had different standards than I did.

"Good. Though that would add another variable," he added thoughtfully. "Well . . . I think Rik can handle it. We'll do it conscious as long as we can."

"And what's going to be your clue that he's *not* handling it? The first time he tries to strangle one of his images? Or maybe when he goes catatonic?"

He gave me an irritated look. "Captain, I *am* a psychiatrist. I'm perfectly capable of reading my patient and picking up any signs of trouble before they become serious. Rik is going to be all right; let's just leave it at that."

I had no intention of leaving it at that: but just then two more of the passengers wandered into the lounge, so I nodded to Lanton and left. We had five days before the next cascade point, and there would be other opportunities in that time to discuss the issue. If necessary, I would manufacture them.

Alana had only negatives for me when I got back to the bridge. "The astrogate's clean," she told me. "I've pulled a hard copy of the program to check, but the odds that a glitch developed that just happened to look reasonable enough to fool the diagnostic are essentially nil." She waved at the long gyroscope needle above us. "Computer further says the vacuum in the gyro chamber stayed hard throughout the maneuver and that there was no malfunction of the mag-bearing fields."

So the gyroscope hadn't been jinxed by friction into giving a false reading. Combined with the results on the astrogate program, that left damn few places to look. "Has Wilkinson checked in?"

"Yes, and I've got him testing the shield for breaks."

"Good. I'll go down and give him a hand. Have you had time to check out our current course?"

"Not in detail, but the settings look all right to me."

"They did to me, too, but if there's

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any chance the computer's developed problems we can't take anything for granted. I don't want to be in the wrong position when it's time for the next point."

"Yeah. Well, Pascal's due up here in ten minutes; I guess the astrogate deep-check can wait until then. What did you find out from Lanton?"

With an effort I switched gears. "According to him, Bradley's not going to be any trouble. He sounds more neurotic than psychotic, from Lanton's description, at least at the moment. Unfortunately, Lanton's got this great plan to use cascade images as a research tool, and intends to keep Bradley awake through every point between here and Taimyr."

"He *what?* I don't suppose he's bothered to consider what that might do to Bradley's problems."

"That's what *I* wanted to know. I never did get an acceptable answer." I moved to the bridge door, poked the release. "Don't worry, we'll pound some sense into him before the next point. See you later."

Wilkinson and Sarojis were both in the number one hold when I arrived, Sarojis offering minor assistance and lots of suggestions as Wilkinson crawled over the shimmery metal box that took up the forward third of the narrow space. Looking down at me as I threaded my way between the other boxes cramming the hold, he shook his head. "Nothing wrong here, Cap'n," he said. "The shield's structurally sound; there's no way the Ming metal inside could affect our configuration."

"No chance of hairline cracks?" I asked.

He held up the detector he'd been using. "I'm checking, but nothing that small would do anything."

I nodded acknowledgment and spent a moment frowning at the box. Ming metal had a number of unique properties inside cascade points, properties that made it both a blessing and a curse to those of us who had to fly with it. Its unique blessing, of course, was that its electrical, magnetic, and thermodynamic properties were affected only by the absolute angle the ship rotated through, and not by any of the hundred or so other variables in a given cascade maneuver. It was this predictability that finally had made it possible for a cascade point autodrive mechanism to be developed. Of more concern to smaller ships like mine, though, was that Ming metal drastically changed a ship's "configuration"—the size, shape, velocity profile, and so on from which the relation between rotation angle and distance traveled on a given maneuver could be computed. Fortunately, the effect was somewhat analogous to air resistance, in that if one piece of Ming metal were completely enclosed in another, only the outer container's shape, size, and mass would affect the configuration. Hence, the shield. But if it hadn't been breached, then the cargo inside it couldn't have fouled us up. . . .

"What are the chances," I asked Wilkinson, "that one of these other boxes contains Ming metal?"

"Without listing it on the manifest?" Sarojis piped up indignantly. He was a dark, intense little man who always seemed loudly astonished whenever anyone did something either unjust or stupid. Most everyone on the *Dancer*

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O.D.'d periodically on his chatter and spent every third day or so avoiding him. Alana and Wilkinson were the only exceptions I knew of, and even Alana got tired of him every so often. "They couldn't do that," Sarojis continued before I could respond. "We could sue them into bankruptcy."

"Only if we make it to Taimyr," I said briefly, my eyes on Wilkinson.

"One way to find out," he returned. Dropping lightly off the shield, he replaced his detector in the open tool box lying on the deck and withdrew a wand-like gadget.

It took two hours to run the wand over every crate in the *Dancer*'s three holds, and we came up with precisely nothing. "Maybe one of the passengers brought some aboard," Sarojis suggested.

"You've go to be richer than any of *our* customers to buy cases with Ming-metal buckles." Wilkinson shook his head. "Cap'n, it's got to be a computer fault, or else something in the gyro."

"Um," I said noncommittally. I hadn't yet told them that I'd checked with Alana midway through all the cargo testing and that she and Pascal had found nothing wrong in their deep-checks of both systems. There was no point in worrying them more than necessary.

I returned to the bridge to find Pascal there alone, slouching in the helm chair and gazing at the displays with a dreamy sort of expression on his face. "Where's Alana?" I asked him, dropping into the other chair and eying the pile of diagnostic print-outs they'd thoughtfully left for me. "Finally gone to bed?"

"She said she was going to stop by the dining room first and have some dinner," Pascal said, the dreamy expression fading somewhat. "Something about meeting the passengers."

I glanced at my watch, realizing with a start that it was indeed dinner time. "Maybe I'll go on down, too. Any problems here, first?"

He shook his head. "I have a theory about the cascade point error," he said, lowering his voice conspiratorially. "I'd rather not say what it is, though, until I've had more time to think about it."

"Sure," I said, and left. Pascal fancied himself a great scientific detective and was always coming up with complex and wholly unrealistic theories in areas far outside his field, with predictable results. Still, nothing he'd ever come up with had been actually dangerous, and there was always the chance he would someday hit on something useful. I hoped this would be that day.

The *Dancer*'s compact dining room was surprisingly crowded for so soon after the first cascade point, but a quick scan of the faces showed me why. Only nine of our twelve passengers had made it out of bed after their first experience with sleepers, but their absence was more than made up by the six crewers who had opted to eat here tonight instead of in the duty mess. The entire off-duty contingent . . . and it wasn't hard to figure out why.

Bradley, seated between Lanton and Tobbar at one of the two tables, was speaking earnestly as I slipped through the door. ". . . less symbolic than it was an attempt to portray the world from a truly alien viewpoint, a viewpoint he would change every few years. Thus *A Midsummer Wedding* has both the slight fish-eye distortion *and* the color shifts

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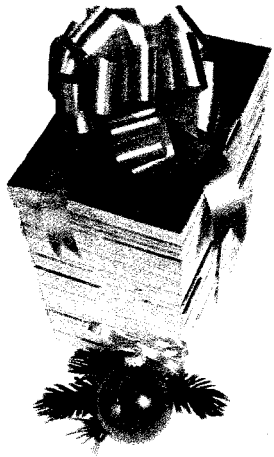

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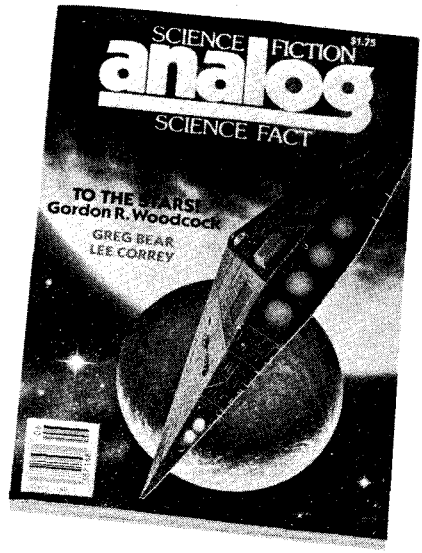

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you might get from a water-dwelling creature; also the subtleties of posture and expression that such an alien wouldn't understand and might therefore not get right."

"But isn't strange sensory expression one of the basic foundations of art?" That was Tobbar—so glib on any topic that you were never quite sure whether he actually knew anything about it or not. "Drawing both eyes on one side of the head, putting nudes at otherwise normal picnics—that sort of thing."

"True, but you mustn't confuse weirdness for its own sake with the consistent, scientifically accurate variations Meyerhäus used."

There was more, but just then Alana caught my eye from her place at the other table and indicated the empty seat next to her. I went over and sat down, losing the train of Bradley's monologue in the process. "Anything?" she whispered to me.

"A very flat zero," I told her.

She nodded once but didn't say anything, and I noticed her gaze drift back to Bradley. "Knows a lot about art, I see," I commented, oddly irritated by her shift in attention.

"You missed his talk on history," she said. "He got quite a discussion going over there—that mathematician, Dr. Chileogu, also seems to be a history buff. First time I've ever seen Tobbar completely frozen out of a discussion. He certainly seems normal enough."

"Tobbar?"

"Bradley."

"Oh." I looked over at Bradley, who was now listening intently to someone holding forth from the other end of his table. *Permanently disoriented*, Lanton had described him. Was he envisioning himself a professor of art or something right now? Or were his delusions that complete? I didn't know; and at the moment I didn't care. "Well, good for him. Now if you'd care to bring your mind back to ship's business, we still have a problem on our hands."

Alana turned back to me, a slight furrow across her forehead. "I'm open to suggestions," she said. "I was under the impression that we were stuck for the moment."

I clenched my jaw tightly over the retort that wanted to come out. We *were* stuck; and until someone else came up with an idea there really wasn't any reason why Alana shouldn't be down here relaxing. "Yeah," I growled, getting to my feet. "Well, keep thinking about it."

"Aren't you going to eat?"

"I'll get something later in the duty mess," I said.

I paused at the door and glanced back. Already her attention was back on Bradley. Heading back upstairs to the duty mess, I programmed myself an unimaginative meal that went down like so much wet cardboard. Afterwards, I went back to my cabin and pulled a tape on cascade point theory.

I was still paging through it two hours later when I fell asleep.

I tried several times in the next five days to run into Lanton on his own, but it seemed that every time I saw him Bradley was tagging along like a well-behaved cocker spaniel. Eventually, I was forced to accept Alana's suggestion that she and Tobbar offer Bradley a tour of the ship, giving me a chance to way-

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lay Lanton in the corridor outside his cabin. The psychiatrist seemed preoccupied and a little annoyed at being so accosted, but I didn't let it bother me.

"No, of course there's no progress yet," he said in response to my question. "I also didn't expect any. The first cascade point observations were my baseline. I'll be asking questions during the next one, and after that I'll start introducing various treatment techniques and observing Rik's reactions to them."

He started to sidle past me, but I moved to block him. "Treatment? You never said anything about treatment."

"I didn't think I had to. I *am* legally authorized to administer drugs and such, after all."

"Maybe on the ground," I told him stiffly. "But out here the ship's doctor is the final medical authority. You will *not* give Bradley any drugs or electronic treatment without first clearing it with Dr. Epstein." Something tugged at my mind, but I couldn't be bothered with tracking it down. "As a matter of fact, I want you to give her a complete list of all drugs you've brought aboard before the next cascade point. Anything addictive or potentially dangerous is to be turned over to her for storage in the sleeper cabinet. Understand?"

Lanton's expression stuck somewhere between irritated and stunned. "Oh, come on, Captain, be reasonable—practically every medicine in the book can be dangerous if taken in excessive doses." His face seemed to recover, settling into a bland sort of neutral as his voice similarly adjusted to match it. "Why do you object so strongly to what I'm trying to do for Rik?"

"I'd hurry with that list, Doctor—the next point's scheduled for tomorrow. Good day." Spinning on my heel, I turned and stalked away.

I called back to Kate Epstein as soon as I reached my cabin and told her about the list Lanton would be delivering to her. I got the impression that she, too, thought I was overreacting, but she nevertheless agreed to cooperate. I extracted a promise to keep me informed on what Lanton's work involved, then signed off and returned once more to the Colloton theory tapes that had occupied the bulk of my time the past four days.

But despite the urgency I was feeling—we had less than twenty hours to the next cascade point—the words on my reader screen refused to coalesce into anything that made sense. I gritted my teeth and kept at it until I discovered myself reading the same paragraph for the fourth time and still not getting a word of it. Snapping off the reader in disgust, I stretched out on my bed and tried to track down the source of my distraction.

Obviously, my irritation at Lanton was a good fraction of it. Along with the high-handed way he treated the whole business of Bradley, he'd now added the insult of talking to me in a tone of voice that implied I needed his professional services—and for nothing worse than insisting on my rights as captain of the *Dancer*. I wished to hell I'd paid more attention to the passenger manifest before I'd let the two of them aboard. Next time I'd know better.

Still . . . I had to admit that maybe I *had* overreacted a bit. But it wasn't as if I was being short-tempered without

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reason. I had plenty of reasons to be worried: Lanton's game of cascade image tag and its possible effects on Bradley, the still unexplained discrepancy in the last point's maneuvers, the changes I was seeing in Alana—

Alana. Up until that moment I hadn't consciously admitted to myself that she was behaving any differently than usual. But I hadn't flown with her for four years without knowing all of her moods and tendencies, and it was abundantly clear to me that she was slowly getting involved with Bradley.

My anger over such an unexpected turn of events was not in any way motivated by jealousy. Alana was her own woman, and any part of her life not directly related to her duties was none of my business. But I knew that, in this case, her involvement was more than likely her old affinity for broken wings, rising like the Phoenix—except that the burning would come afterwards instead of beforehand. I didn't want to see Alana go through that again, especially with someone whose presence I felt responsible for. There was, of course, little I could do directly without risking Alana's notice and probable anger; but I could let Lanton know how I felt by continuing to make things as difficult for him as possible. And I would.

And with that settled, I managed to push it aside and return to my studies. It is, I suppose, revealing that it never occurred to me at the time how inconsistent my conclusion and proposed course of action really were. After all, the faster Lanton cured Bradley, the faster the broken-wing attraction would disappear and—presumably—the easier Alana would be able to extricate herself. Perhaps, even then, I was secretly starting to wonder if her attraction to him was something more than altruistic.

"Two minutes," Alana said crisply from my right, her tone almost but not quite covering the tension I knew she must be feeling. "Gyro checks out perfectly."

I made a minor adjustment in my mirror, confirmed that the long needle was set dead on zero. Behind the mirror, the displays stared blankly at me from the control board, their systems having long since been shut down. I looked at the computer's print-out, the field generator control cover, my own hands —anything to keep from looking at Alana. Like me, she was unaccustomed to company during a cascade point, and I was determined to give her what little privacy I could.

"One minute," she said. "You sure we made up enough distance for this to be safe?"

"Positive. The only possible trouble could have come from Epsilon Eridani, and we've made up enough lateral distance to put it the requisite six degrees off our path."

"Do you suppose that could have been the trouble last time? Could we have come too close to something—a black dwarf, maybe, that drifted into our corridor?"

I shrugged, eyes on the clock. "Not according to the charts. Ships have been going to Taimyr a long time, you know, and the whole route's been pretty thoroughly checked out. Even black dwarfs have to come *from* somewhere." Gritting my teeth, I flipped the cover off the knob. "Brace yourself; here we go."

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Doing a cascade point alone invites introspection, memories of times long past, and melancholy. Doing it with someone else adds instant vertigo and claustrophobia to the list. Alana's images and mine still appeared in the usual horizontal cross shape, but since we weren't seated facing exactly the same direction, they didn't overlap. The result was a suffocatingly crowded bridge —crowded, to make things worse, with images that were no longer tied to your own motions, but would twitch and jerk apparently on their own.

For me, the disadvantages far outweighed the single benefit of having someone there to talk to, but in this case I had had little choice. Alana had steadfastly refused to let me take over from her on two points in a row, and I'd been equally insistent on being awake to watch the proceedings. It was a lousy compromise, but I'd known better than to order Alana off the bridge. She had her pride, too.

"Activating flywheel."

Alana's voice brought my mind back to business. I checked the print-out one last time, then turned my full attention to the gyro needle. A moment later it began its slow creep, and the dual set of cascade images started into their own convoluted dances. Swallowing hard, I gave my stomach stern orders and held on.

It seemed at times to be lasting forever, but finally it was over. The *Dancer* had been rotated, had been brought to a stop, and had successfully made the transition to real space. I slumped in my seat, feeling a mixture of cascade depression and only marginally decreased tension. The astrogate program's verdict, after all, was still to come.

But I was spared the ordeal of waiting with twiddled thumbs for the computer. Alana had barely gotten the ship's systems going again when the intercom bleeped at me. "Bridge," I answered.

"This is Dr. Lanton," the tight response came. "There's something very wrong with the power supply to my cabin—one of my instruments just burned out on me."

"Is it on fire?" I asked sharply, eyes flicking to the status display. Nothing there indicated any problem.

"Oh, no—there was just a little smoke and that's gone now. But the thing's ruined."

"Well, I'm sorry, Doctor," I said, trying to sound like I meant it. "But I can't be responsible for damage to electronics that are left running through a cascade point. Even something as simple as an AC power line can show small voltage fluc—*oh, damn it!*"

Alana jerked at my exclamation. "What—"

"Lanton!" I snapped, already halfway out of my seat. "Stay put and *don't touch anything*. I'm coming down."

His reply was more question than acknowledgment, but I ignored it. "Alana," I called to her, "call Wilkinson and have him meet me at Lanton's cabin—and tell him to bring a Ming metal detector."

I caught just a glimpse of her suddenly horrified expression before the door slid shut and I went running down the corridor. There was no reason to run, but I did so anyway.

It was there, of course: a nice, neat Ming-metal dual crossover coil, smack

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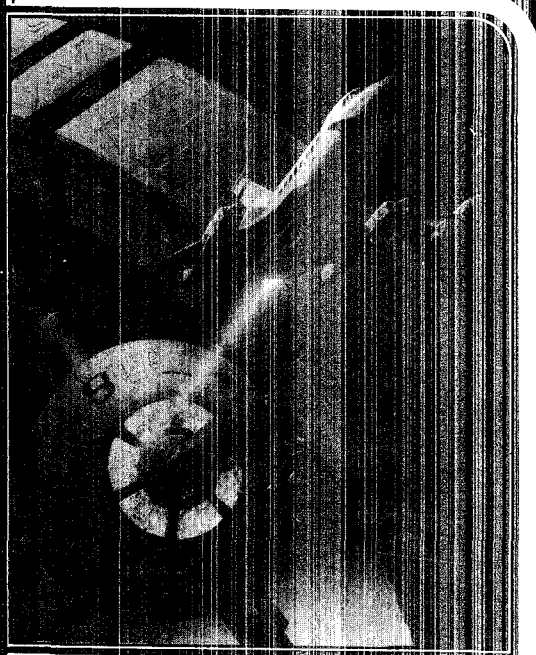

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in the center of the ruined neural tracer. At least it *had* been neat; now it was stained with a sticky goo that had dripped onto it from the blackened circuit board above. "Make sure none of it melted off onto something else," I told Wilkinson as he carefully removed the coil. "If it has we'll either have to gut the machine or find a way to squeeze it inside the shield." He nodded and I stepped over to where Lanton was sitting, the white-hot anger inside me completely overriding my usual depression. "What the *hell* did you think you were doing, bringing that damn thing aboard?" I thundered, dimly aware that the freshly sedated Bradley might hear me from the next cabin but not giving a damn.

His voice, when he answered, was low and artificially calm—whether in stunned reaction to my rage or simply a reflexive habit I didn't know. "I'm very sorry, Captain, but I swear I didn't know the tracer had any Ming metal in it."

"Why not? You told me yourself you could buy things with Ming-metal parts." And I'd let that fact sail blithely by me, a blunder on my part that was probably fueling ninety percent of my anger.

"But I never see the manufacturing specs on anything I use," he said. "It all comes through the Institute's receiving department, and all I get are the operating manuals and such." His eyes flicked to his machine as if he were going to object to Wilkinson's manhandling of it. "I guess they must have removed any identification tags, as well."

"I guess they must have," I ground out. Wilkinson had the coil out now, and I watched as he laid it aside and picked up the detector wand again. A minute later he shook his head.

"Clean, Cap'n," he told me, picking up the coil again. "I'll take this to One Hold and put it away."

I nodded and he left. Gesturing to the other gadgets spread around the room, I asked, "Is this all you've got, or is there more in Bradley's cabin?"

"No, this is it," Lanton assured me.

"What about your stereovision camera? I know some of those have Ming metal in them."

He frowned. "I don't have any cameras. Who told you I did?"

"I—" I frowned in turn. "You said you were studying Bradley's cascade images."

"Yes, but you can't take pictures of them. They don't register on any kind of film."

I opened my mouth, closed it again. I was sure I'd known that once, but after years of watching the images I'd apparently clean forgotten it. They were so lifelike . . . and I was perhaps getting old. "I assumed someone had come up with a technique that worked," I said stiffly, acutely aware that my attempt to save face wasn't fooling either of us. "How *do* you do it, then?"

"I memorize all of it, of course. Psychiatrists have to have good memories, you know, and there are several drugs that can enhance one's basic abilities."

I'd heard of mnemonic drugs. They were safe, extremely effective, and cost a small fortune. "Do you have any of them with you? If so, I'm going to insist they be locked away."

He shook his head. "I was given a six-month treatment at the Institute before we left. That's the main reason

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we're on your ship, by the way, instead of something specially chartered. Mnemonic drugs play havoc with otherwise reasonable budgets."

He was making a joke, of course, but it was an exceedingly tasteless one, and the anger that had been draining out of me reversed its flow. No one needed to remind me that the *Dancer* wasn't up to the Cunard line's standards. "My sympathies to your budget," I said briefly. Turning away, I strode to the door.

"Wait a minute," he called after me. "What are my chances of getting that neural tracer fixed?"

I glanced back over my shoulder. "That probably depends on how good you are with a screwdriver and solder gun," I said, and left.

Alana was over her own cascade depression by the time I returned to the bridge. "I was right," I said as I dropped into my seat. "One of his damned black boxes had a Ming-metal coil."

"I know; Wilkinson called from One Hold." She glanced sideways at me. "I hope you didn't chew Lanton out in front of Bradley."

"Why not?"

"Did you?"

"As it happens, no. Lanton sedated him right after the point again. Why does it matter?"

"Well . . ." She seemed embarrassed. "It might . . . upset him to see you angry. You see, he sort of looks up to you—captain of a star ship and all—"

"Captain of a struggling tramp," I corrected her more harshly than was necessary. "Or didn't you bother to tell him that we're the absolute bottom of the line?"

"I told him," she said steadily. "But he doesn't see things that way. Even in five days aboard he's had a glimpse of how demanding this kind of life is. He's never been able to hold down a good job himself for very long, and that adds to the awe he feels for all of us."

"I can tell he's got a lot to learn about the universe," I snorted. For some reason the conversation was making me nervous, and I hurried to bring it back to safer regions. "Did your concern for Bradley's idealism leave you enough time to run the astrogate?"

She actually blushed, the first time in years I'd seen her do that. "Yes," she said stiffly. "We're about thirty-two light-days short this time."

"Damn." I hammered the edge of the control board once with my clenched fist, and then began punching computer keys.

"I've already checked that," Alana spoke up. "We'll dig pretty deep into our fuel reserve if we try to make it up through normal space."

I nodded, my fingers coming to a halt. My insistence on maintaining a high fuel reserve was one of the last remnants of Lord Hendrik's training that I still held onto, and despite occasional ribbing from other freighter captains I felt it was a safety precaution worth taking. The alternative to using it, though, wasn't especially pleasant. "All right," I sighed. "Let's clear out enough room for the computer to refigure our course profile. If possible, I'd like to tack the extra fifty light-days onto one of the existing points instead of adding a new one."

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She nodded and started typing away at her console as I called down to the engine room to alert Matope. It was a semimajor pain, but the *Dancer*'s computer didn't have enough memory space to handle the horribly complex Colloton calculations we needed while all the standard operations programming was in place. We would need to shift all but the most critical functions to Matope's manual control, replacing the erased programs later from Pascal's set of master tapes.

It took nearly an hour to get the results, but they turned out to be worth the wait. Not only could we make up our shortfall without an extra point, but with the slightly different stellar configuration we faced now it was going to be possible to actually shorten the duration of one of the points further down the line. That was good news from both practical and psychological considerations. Though I've never been able to prove it, I've long believed that the deepest depressions follow the longest points.

I didn't see any more of Lanton that day, though I heard later that he and Bradley had mingled with the passengers as they always did, Lanton behaving as if nothing at all had happened. Though I knew my crew wasn't likely to go around blabbing about Lanton's Ming metal blunder, I issued an order anyway to keep the whole matter quiet. It wasn't to save Lanton any embarrassment—that much I was certain of—but beyond that my motives became uncomfortably fuzzy. I finally decided I was doing it for Alana, to keep her from having to explain to Bradley what an idiot his therapist was.

* * *

The next point, six days later, went flawlessly, and life aboard ship finally settled into the usual deep-space routine. Alana, Pascal, and I each took eight-hour shifts on the bridge; Matope, Tobbar, and Sarojis did the same back in the engine room; and Kate Epstein, Leeds, and Wilkinson took turns catering to the occasional whims of our passengers. Off-duty, most of the crewers also made an effort to spend at least a little time in the passenger lounge, recognizing the need to be friendly in the part of our business that was mainly word of mouth. Since that first night, though, the exaggerated interest in Bradley The Mental Patient had pretty well evaporated, leaving him as just another passenger in nearly everyone's eyes.

The exception, of course, was Alana.

In some ways, watching her during those weeks was roughly akin to watching a baby bird hacking its way out of its shell. Alana's bridge shift followed mine, and I was often more or less forced to hang around for an hour or so listening to her talk about her day. *Forced* is perhaps the wrong word; obviously, no one was nailing me to my chair. And yet, in another sense, I really *did* have no choice. To the best of my knowledge, I was Alana's only real confidant aboard the *Dancer*, and to have refused to listen would have deprived her of her only verbal sounding board. And the more I listened, the more I realized how vital my participation really was . . . because along with the usual rolls, pitches, and yaws of every embryo relationship, this one had an extra com-

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plication: Bradley's personality was beginning to change.

Lanton had said he was on the verge of a breakthrough, but it had never occurred to me that he might be able to begin genuine treatment aboard ship, let alone that any of its effects would show up en route. But even to me, who saw Bradley for maybe ten minutes at a time three times a week, the changes were obvious. All the conflicting signals in posture and expression that had bothered me so much at our first meeting diminished steadily until they were virtually gone, showing up only on brief occasions. At the same time, his self-confidence began to increase, and a heretofore unnoticed—by me, at least—sense of humor began to manifest itself. The latter effect bothered me, until Alana explained that a proper sense of humor required both a sense of dignity and an ability to take oneself less than seriously, neither of which Bradley had ever had before. I was duly pleased for her at the progress this showed; privately, I sought Lanton out to find out exactly what he was doing to his patient and the possible hazards thereof. The interview was easy to obtain—Bradley was soloing quite a bit these days—but relatively uninformative. Lanton tossed around a lot of stuff about synaptic fixing and duplicate messenger chemistry, but with visions of a Nobel Prize almost visibly orbiting his head he was in no mood to worry about dangerous side effects. He assured me that nothing he was using was in the slightest way experimental, and that I should go back to flying the *Dancer* and let him worry about Bradley. Or words to that effect.

I really *was* happy for Bradley, of course, but the fact remained that his rapid improvement was playing havoc with Alana's feelings. After years away from the wing-mending business she felt herself painfully rusty at it; and as Bradley continued to get better despite that, she began to wonder out loud whether she was doing any good, and if not, what right she had to continue hanging around him. At first I thought this was just an effort to hide the growth of other feelings from me, but gradually I began to realize that she was as confused about what was happening as she sounded. Never before in her life, I gathered, had romantic feelings come to her without the framework of a broken-wing operation to both build on and help disguise, and with that scaffolding falling apart around her she was either unable or unwilling to admit to herself what was really going on.

I felt pretty rotten having to sit around watching her flounder, but until she was able to recognize for herself what was happening there wasn't much I could do except listen. I wasn't about to offer any suggestions, especially since I didn't believe in love at first sight in the first place. My only consolation was that Bradley and Lanton were riding round trip with us, which meant that Alana wouldn't have to deal with any sort of separation crisis until we were back on Earth. I'd never before had much sympathy for people who expected time to solve all their problems for them, but in this case I couldn't think of anything better to do.

And so matters stood as we went through our eighth and final point and emerged barely eight hundred thousand kilometers from the thriving colony

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world Taimyr . . . and found it deserted.

"Still nothing," Alana said tightly, her voice reflecting both the remnants of cascade depression and the shock of our impossible discovery. "No response to our call; nothing on any frequency I can pick up. I can't even find the comm satellites' lock signal."

I nodded, my eyes on the scope screen as the *Dancer*'s telescope slowly scanned Taimyr's dark side. No lights showed anywhere. Shifting the aim, I began searching for the nine comm and nav satellites that should be circling the planet. "Alana, call up the astrogate again and find out what it's giving as position uncertainty."

"If you're thinking we're in the wrong system, forget it," she said as she tapped keys.

"Just checking all possibilities," I muttered. The satellites, too, were gone. I leaned back in my seat and bit at my lip.

"Yeah. Well, from eighteen positively identified stars we've got an error of no more than half a light-hour." She swiveled to face me and I saw the fear starting to grow behind her eyes. "Pall, what is going *on* here? Two hundred million people can't just disappear without a trace."

I shrugged helplessly. "A nuclear war could do it, I suppose, and might account for the satellites being gone as well. But there's no reason why anyone on Taimyr should *have* any nuclear weapons." Leaning forward again, I activated the helm. "A better view might help. If there's been some kind of war the major cities should now be big craters surrounded by rubble. I'm going to take us in and see what the day side looks like from high orbit."

"Do you think that's safe? I mean—" She hesitated. "Suppose the attack came from outside Taimyr."

"What, you mean like an invasion?" I shook my head. "Even if there are alien intelligences somewhere who would want to invade us, we stand just as good a chance of getting away from orbit as we do from here."

"All right," she sighed. "But I'm setting up a cascade point maneuver, just in case. Do you think we should alert everybody yet?"

"Crewers, yes; passengers, no. I don't want any silly questions until I'm ready to answer them."

We took our time approaching Taimyr, but caution turned out to be unnecessary. No ships, human or otherwise, waited in orbit for us; no one hailed or shot at us; and as I turned the telescope planetward I saw no signs of warfare.

Nor did I see any cities, farmland, factories, or vehicles. It was as if Taimyr the colony had never existed.

"It doesn't make any sense," Matope said after I'd explained things over the crew intercom hookup. "How could a whole colony disappear?"

"I've looked up the records we've got on Taimyr," Pascal spoke up. "Some of the tropical vegetation is pretty fierce in the growth department. If everyone down there was killed by a plague or something, it's possible the plants have overgrown everything."

"Except that most of the cities are in temperate regions," I said shortly, "and two are smack in the middle of deserts. I can't find any of those, either."

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"Hmm," Pascal said and fell silent, probably already hard at work on a new theory.

"Captain, you don't intend to land, do you?" Sarojis asked. "If launch facilities are gone and not merely covered over we'd be unable to lift again to orbit."

"I'm aware of that, and I have no intention of landing," I assured him. "But something's happened down there, and I'd like to get back to Earth with at least *some* idea of what."

"Maybe nothing's happened to the colony," Wilkinson said slowly. "Maybe something's happened to *us*."

"Such as?"

"Well . . . this may sound strange, but suppose we've somehow gone back in time, back to before the colony was started."

"That's crazy," Sarojis scoffed before I could say anything. "How could we possibly do something like that?"

"Malfunction of the field generator, maybe?" Wilkinson suggested. "There's a lot we don't know about Colloton space."

"It *doesn't* send ships back in—"

"All right, ease up," I told Sarojis. Beside me Alana snorted suddenly and reached for her keyboard. "I agree the idea sounds crazy, but whole cities don't just walk off, either," I continued. "It's not like there's a calendar we can look at out here, either. If we *were* a hundred years in the past, how would we know it?"

"Check the star positions," Matope offered.

"No good; the astrogate program would have noticed if anything was too far out of place. But I expect that still leaves us a possible century or more to rattle around in."

"No, it doesn't." Alana turned back to me with a grimly satisfied look on her face. "I've just taken signals from three pulsars. Compensating for our distance from Earth gives the proper rates for all three."

"Any comments on that?" I asked, not expecting any. Pulsar signals occasionally break their normal pattern and suddenly increase their pulse frequency, but it was unlikely to have happened in three of the beasts simultaneously; and in the absence of such a glitch the steady decrease in frequency was as good a calendar as we could expect to find.

There was a short pause, then Tobbar spoke up. "Captain, I think maybe it's time to bring the passengers in on this. We can't hide the fact that we're in Taimyr system, so they're bound to figure out sooner or later that something's wrong. And I think they'll be more cooperative if we volunteer the information rather than making them demand it."

"What do we need *their* cooperation for?" Sarojis snorted.

"If you bothered to listen as much as you talked," Tobbar returned, a bit tartly, "you'd know that Chuck Raines is an advanced student in astrophysics and Dr. Chileogu has done a fair amount of work on Colloton field mathematics. I'd say chances are good that we're going to need help from one or both of them before this is all over."

I looked at Alana, raised my eyebrows questioningly. She hesitated, then nodded. "All right," I said. "Matope, you'll stay on duty down there; Alana

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will be in command here. Everyone else will assemble in the dining room. The meeting will begin in ten minutes."

I waited for their acknowledgments and then flipped off the intercom. "I'd like to be there," Alana said.

"I know," I said, raising my palms helplessly. "But I *have* to be there, and someone's got to keep an eye on things outside."

"Pascal or Sarojis could do it."

"True—and under normal circumstances I'd let them. But we're facing an unknown and potentially dangerous situation, and I need someone here whose judgment I trust."

She took a deep breath, exhaled loudly. "Yeah. Well . . . at least let me listen in by intercom, okay?"

"I'd planned to," I nodded. Reaching over, I touched her shoulder. "Don't worry; Bradley can handle the news."

"I know," she said, with a vehemence that told me she wasn't anywhere near that certain.

Sighing, I flipped the P.A. switch and made the announcement.

They took the news considerably better than I'd expected them to—possibly, I suspected, because the emotional kick hadn't hit them yet.

"But this is absolutely unbelievable, Captain Durriken," Lissa Steadman said when I'd finished. She was a rising young business administration type who I half expected to call for a committee to study the problem. "How could a whole colony simply vanish?"

"My question exactly," I told her. "We don't know yet, but we're going to try and find out before we head back to Earth."

"We're just going to leave?" Mr. Eklund asked timidly from the far end of the table. His hand, on top of the table, gripped his wife's tightly, and I belatedly remembered they'd been going to Taimyr to see a daughter who'd emigrated some thirty years earlier. Of all aboard, they had lost the most when the colony vanished.

"I'm sorry," I told him, "but there's no way we could land and take off again, not if we want to make Earth again on the fuel we have left."

Eklund nodded silently. Beside them, Chuck Raines cleared his throat. "Has anybody considered the possibility that *we're* the ones something has happened to? After all, it's the *Aura Dancer*, not Taimyr, that's been dipping in and out of normal space for the last six weeks. Maybe during all that activity something went wrong."

"The floor is open for suggestions," I said.

"Well . . . I presume you've confirmed we *are* in the Taimyr system. Could we be—oh—out of phase or something with the real universe?"

"Highly poetic," Tobbar spoke up from his corner. "But what does *out of phase* physically mean in this case?"

"Something like a parallel universe, or maybe an alternate time line," Raines suggested. "Some replica of our universe where humans never colonized Taimyr. After all, cascade images are supposed to be views of alternate universes, aren't they? Maybe cascade points are somehow where all the possible paths intersect."

"You've been reading too much science fiction," I told him. "Cascade images are at least partly psychological,

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and they certainly have no visible substance. Besides, if you had to trace the proper path through a hundred universes every time you went through a cascade point, you'd lose ninety-nine ships out of every hundred that tried it."

"Actually, Mr. Raines is not being all *that* far out," Dr. Chileogu put in quietly. "It's occasionally been speculated that the branch cuts and Riemann surfaces that show up in Colloton theory represent distinct universes. If so, it would be theoretically possible to cross between them." He smiled slightly. "But it's extremely unlikely that a responsible captain would put his ship through the sort of maneuver that would be necessary to do such a thing."

"What sort of maneuver would it take?" I asked.

"Basically, a large-angle rotation within the cascade point. Say, eight degrees or more."

I shook my head, feeling relieved and at the same time vaguely disappointed that a possible lead had evaporated. "Our largest angle was just under four point five degrees."

He shrugged. "As I said."

I glanced around the table, wondering what avenue to try next. But Wilkinson wasn't ready to abandon this one yet. "I don't understand what the ship's rotation has to do with it, Dr. Chileogu," he said. "I thought the farther you rotated, the farther you went in real space, and that was all."

"Well . . . it would be easier if I could show you the curves involved. Basically, you're right about the distance-angle relation as long as you stay below that eight degrees I mentioned. But above that point there's a discontinuity, similar to what you get in the curve of the ordinary tangent function at ninety degrees; though unlike the tangent the next arm doesn't start at minus infinity." Chileogu glanced around the room, and I could see him revising the level of his explanation downward. "Anyway, the point is that the first arm of the curve—real rotations of zero to eight point six degrees—gives the complete range of translation distance from zero to infinity, and so that's all a star ship ever uses. If the ship rotates *past* that discontinuity, mathematical theory would say it had gone off the edge of the universe and started over again on a different Riemann surface. What that means physically I don't think anyone knows; but as Captain Durriken pointed out, all our real rotations have been well below the discontinuity."

Wilkinson nodded, apparently satisfied; but the term "real rotation" had now set off a warning bell deep in my own mind. It was an expression I hadn't heard—much less thought about—in years, but I vaguely remembered now that it had concealed a seven-liter can of worms. "Doctor, when you speak of a 'real' rotation, you're referring to a mathematical entity, as opposed to an actual, physical one," I said slowly. "Correct?"

He shrugged. "Correct, but with a ship such as this the two are for all practical purposes identical. The *Aura Dancer* is a long, perfectly symmetrical craft, with both the Colloton field generator and Ming-metal cargo shield along the center line. It's only when you start working with the fancier liners, with their towers and blister lounges and all, that you get a serious divergence."

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I nodded carefully and looked around the room. Pascal had already gotten it, from the expression on his face; Wilkinson and Tobbar were starting to. "Could an extra piece of Ming metal, placed several meters off the ship's center line, cause such a divergence?" I asked Chileogu.

"Possibly," he frowned. "Very possibly."

I shifted my gaze to Lanton. His face had gone white. "I think," I said, "I've located the problem."

Seated at the main terminal in Pascal's cramped computer room, Chileogu turned the Ming-metal coil over in his hands and shook his head. "I'm sorry, Captain, but it simply can't be done. A dual crossover winding is one of the most complex shapes in existence, and there's no way I can calculate its effect with a computer this small."

I glanced over his head at Pascal and Lanton, the latter having tagged along after I cut short the meeting and hustled the mathematician down here. "Can't you even get us an estimate?" I asked.

"Certainly. But the estimate could be anywhere up to a factor of three off, which would be worse than useless to you."

I nodded, pursing my lips tightly. "Well, then, how about going on from here? With that coil back in the shield, the real and physical rotations coincide again. Is there some way we can get back to our universe; say, by taking a long step out from Taimyr and two short ones back?"

Chileogu pondered that one for a long minute. "I would say that it depends on how many universes we're actually dealing with," he said at last. "If there are just two—ours and this one—then rotating past any one discontinuity should do it. But if there are more than two, you'd wind up just going one deeper into the stack if you crossed the wrong line."

"Ouch," Pascal murmured. "And if there are an infinite number, I presume, we'd never get back out?"

The mathematician shrugged uncomfortably. "Very likely."

"But don't the mathematics show how many universes there are?" Lanton spoke up.

"They show how many Riemann surfaces there are," Chileogu corrected. "But physical reality is never obliged to correspond with our theories and constructs. Experimental checks are always required, and to the best of my knowledge no one has ever tried this one."

I thought of all the ships that had simply disappeared, and shivered slightly. "In other words, trying to find the Taimyr colony is out. All right, then. What about the principle of reversibility? Will that let us go back the way we came?"

"Back to Earth?" Chileogu hesitated. "Ye-e-s, I think that would apply here. But to go back don't you need to know . . . ?"

"The real rotations we used to get here," I nodded heavily. "Yeah." We looked at each other, and I saw that he, too, recognized the implications of that requirement.

Lanton, though, was still light-years behind us. "You act like there's still a problem," he said, looking back and forth between us. "Don't you have records of the rotations we made at each point?"

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I was suddenly tired of the psychiatrist. "Pascal, would you explain things to Dr. Lanton—on your way back to the passenger area?"

"Sure." Pascal stepped to Lanton's side and took his arm. "This way, Doctor."

"But—" Lanton's protests were cut off by the closing door.

I sat down carefully on a corner of the console, staring back at the Korusyn 630 that took up most of the room's space. "I take it," Chileogu said quietly, "that you can't get the return trip parameters?"

"We can get all but the last two points we'd need," I told him. "The ship's basic configuration was normal for all of those, and the Korusyn there can handle them." I shook my head. "But even for those the parameters will be totally different—a two-degree rotation one way might become a one or three on the return trip. It depends on our relation to the galactic magnetic field and angular momentum vectors, closest-approach distance to large masses, and a half-dozen other parameters. Even if we *had* a mathematical expression for the influence Lanton's damn coil had on our first two points, I wouldn't know how to reprogram the machine to take that into account."

Chileogu was silent for a moment. Then, straightening up in his seat, he flexed his fingers. "Well, I suppose we have to start somewhere. Can you clear me a section of memory?"

"Easily. What are you going to do?"

He picked up the coil again. "I can't do a complete calculation, but there are several approximation methods that occasionally work pretty well; they're scattered throughout my technical tapes if your library doesn't have a list. If they give widely varying results—as they probably will, I'm afraid—then we're back where we started. But if they happen to show a close agreement, we can probably use the result with reasonable confidence." He smiled slightly. "*Then* we get to worry about programming it in."

"Yeah. Well, first things first. Alana, have you been listening in?"

"Yes," her voice came promptly through the intercom. "I'm clearing the computer now."

Chileogu left a moment later to fetch his tapes. Pascal returned while he was gone, and I filled him in on what we were going to try. Together, he and Alana had the computer ready by the time Chileogu returned. I considered staying to watch, but common sense told me I would just be in the way, so instead I went up to the bridge and relieved Alana. It wasn't really my shift, but I didn't feel like mixing with the passengers, and I could think and brood as well on the bridge as I could in my cabin. Besides, I had a feeling Alana would like to check up on Bradley.

I'd been sitting there staring at Taimyr for about an hour when the intercom bleeped. "Captain," Alana's voice said, "can you come down to the dining room right away? Dr. Lanton's come up with an idea I think you'll want to hear."

I resisted my reflexive urge to tell her what Lanton could do with his ideas; her use of my title meant she wasn't alone. "All right," I sighed. "I'll get Sarojis to take over here and be down in a few minutes."

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"I think Dr. Chileogu and Pascal should be here, too."

Something frosty went skittering down my back. Alana knew the importance of what those two were doing. Whatever Lanton's brainstorm was, she must genuinely think it worth listening to. "All right. We'll be there shortly."

They were all waiting quietly around one of the tables when I arrived. Bradley, not surprisingly, was there too, seated next to Alana and across from Lanton. Only the six of us were present; the other passengers, I guessed, were keeping the autobar in the lounge busy. "Okay, let's have it," I said without preamble as I sat down.

"Yes, sir," Lanton said, throwing a quick glance in Pascal's direction. "If I understood Mr. Pascal's earlier explanation correctly, we're basically stuck because there's no way to calibrate the *Aura Dancer*'s instruments to take the, uh, extra Ming metal into account."

"Close enough," I grunted. "So?"

"So, it occurred to me that this 'real' rotation you were talking about ought to have some external manifestation, the same way a gyro needle shows the ship's physical rotation."

"You mean like something outside the viewports?" I frowned.

"No; something inside. I'm referring to the cascade images."

I opened my mouth, closed it again. My first thought was that it was the world's dumbest idea, but my second was *why not?* "You're saying, what, that the image-shuffling that occurs while we rotate is tied to the real rotation, each shift being a hundredth of a radian or something?"

"Right," he nodded, "although I don't know whether that kind of calibration would be possible."

I looked at Chileogu. "Doctor?"

The mathematician brought his gaze back from infinity. "I'm not sure what to say. The basic idea is actually not new—Colloton himself showed such a manifestation ought to be present, and several others have suggested the cascade images were it. But I've never heard of any actual test being made of the hypothesis; and from what I've heard of the images, I suspect there are grave practical problems, besides. The pattern doesn't change in any mathematically predictable way, so I don't know how you would keep track of the shifts."

"I wouldn't have to," Lanton said. "I've been observing Rik's cascade images throughout the trip. I remember what the pattern looked like at both the beginning and ending of each rotation."

I looked at Bradley, suddenly understanding. His eyes met mine and he nodded fractionally.

"The only problem," Lanton continued, "is that I'm not sure we could set up at either end to do the reverse rotation."

"Chances are good we can," I said absently, my eyes still on Bradley. His expression was strangely hard for someone who was supposedly seeing the way out of permanent exile. Alana, if possible, looked even less happy. "All rotations are supposed to begin at zero, and since we always go 'forward' we always rotate the same direction."

I glanced back at Lanton to see his eyes go flat, as if he were watching a private movie. "You're right; it *is* the same starting pattern each time. I hadn't

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really noticed that before, with the changes and all.''

''It should be easy enough to check, Captain,'' Pascal spoke up. ''We can compute the physical rotations for the first six points we'll be going through. The real rotations should be the same as on the outbound leg, though, so if Dr. Lanton's right the images will wind up in the same pattern they did before.''

''But how—?'' Chileogu broke off suddenly. ''Ah. You've had a mnemonic treatment?''

Lanton nodded and then looked at me. ''I think Mr. Pascal's idea is a good one, Captain, and I don't see any purpose in hanging around here any longer than necessary. Whenever you want to start back—''

''I have a few questions to ask first,'' I interrupted mildly. I glanced again at Bradley, decided to tackle the easier ones first. ''Dr. Chileogu, what's the status of your project?''

''The approximations? We've just finished programming the first one; it'll take another hour or so to collect enough data for a plot. I agree with Dr. Lanton, though—we can do the calculations between cascade points as easily as we can do them in orbit here.''

''Thank you. Dr. Lanton, you mentioned something about *changes* a minute ago. What exactly did you mean?''

Lanton's eyes flicked to Bradley for an instant. ''Well . . . as I told you several weeks ago, a person's mind has a certain effect on the cascade image pattern. Some of the medicines Rik's been taking have slightly altered the—oh, I guess you could call it the *texture* of the pattern.''

''Altered it how much?''

''In some cases, fairly extensively.'' He hesitated, just a bit too long. ''But nothing I've done is absolutely irreversible. I should be able to recreate the original conditions before each cascade point.''

Deliberately, I leaned back in my chair. ''All right. Now let's hear what the problem is.''

''I beg your pardon?''

''You heard me.'' I waved at Bradley and Alana. ''Your patient and my first officer look like they're about to leave for a funeral. I want to know why.''

Lanton's cheek twitched. ''I don't think this is the time or the place to discuss—''

''The problem, Captain,'' Bradley interrupted quietly, ''is that the reversing of the treatments may turn out to be permanent.''

It took a moment for that to sink in. When it did I turned my eyes back on Lanton. ''Explain.''

The psychiatrist took a deep breath. ''The day after the second point I used ultrasound to perform a type of minor neurosurgery called synapse fixing. It applies heat to selected regions of the brain to correct a tendency of the nerves to misfire. The effects *can* be reversed . . . but the procedure's been done only rarely, and usually involves unavoidable peripheral damage.''

I felt my gaze hardening into an icy stare. ''In other words,'' I bit out, ''not only will the progress he's made lately be reversed, but he'll likely wind up worse off than he started. Is that it?''

Lanton squirmed uncomfortably, avoiding my eyes. ''I don't *know* that he will. Now that I've found a treatment—''

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"You're about to give him a brand-new disorder," I snapped. "*Damn* it all, Lanton, you are the most cold-blooded—"

"Captain."

Bradley's single word cut off my flow of invective faster than anything but hard vacuum could have. "What?" I said.

"Captain, I understand how you feel." His voice was quiet but firm; and though the tightness remained in his expression, it had been joined by an odd sort of determination. "But Dr. Lanton wasn't really trying to maneuver you into supporting something unethical. For the record, I've already agreed to work with him on this; I'll put that on tape if you'd like." He smiled slightly. "And before you bring it up, I *am* recognized as legally responsible for my actions, so as long as Dr. Lanton and I agree on a course of treatment your agreement is not required."

"That's not entirely true," I ground out. "As a ship's captain in deep space, I have full legal power here. If I say he can't do something to you, he can't. Period."

Bradley's face never changed. "Perhaps. But unless you can find another way to get us back to Earth, I don't see that you have any other choice."

I stared into those eyes for a couple of heartbeats. Then, slowly, my gaze swept the table, touching in turn all the others as they sat watching me, awaiting my decision. The thought of deliberately sending Bradley back to his permanent disorientation—*really* permanent, this time—left a taste in my mouth that was practically gagging in its intensity. But Bradley was right . . . and at the moment I didn't have any better ideas.

"Pascal," I said, "you and Dr. Chileogu will first of all get some output on that program of yours. Alana, as soon as they're finished you'll take the computer back and calculate the parameters for our first point. *You* two—" I glared in turn at Bradley and Lanton—"will be ready to test this image theory of yours. You'll do the observations in your cabin as usual, and tell me afterward whether we duplicated the rotation exactly or came out short or long. Questions? All right; dismissed."

After all, I thought amid the general scraping of chairs, *for the first six points all Bradley will need to do is cut back on medicines. That means twenty-eight days or so before any irreversible surgery is done.*

I had just that long to come up with another answer.

We left orbit three hours later, pushing outward on low drive to conserve fuel. That plus the course I'd chosen meant another ten hours until we were in position for the first point, but none of that time was wasted. Pascal and Chileogu were able to program and run two more approximation schemes; the results, unfortunately, were not encouraging. Any two of the three plots had a fair chance of agreeing over ranges of half a degree or so, but there was no consistency at all over the larger angles we would need to use. Chileogu refused to throw in the towel, pointing out that he had another six methods to try and making vague noises about statistical curve-fitting schemes. I promised him all the computer time he needed between

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point maneuvers, but privately I conceded defeat. Lanton's method now seemed our only chance . . . if it worked.

I handled the first point myself, double-checking all parameters beforehand and taking special pains to run the gyro needle as close to the proper angle as I could. As with any such hand operation, of course, perfection was not quite possible, and I ran the *Dancer* something under a hundredth of a degree long. I'm not sure what I was expecting from this first test, but I *was* more than a little surprised when Lanton accurately reported that we'd slightly overshot the mark.

"It looks like it'll work," Alana commented from her cabin when I relayed the news. She didn't sound too enthusiastic.

"Maybe," I said, feeling somehow the need to be as skeptical as possible. "We'll see what happens when he starts taking Bradley off the drugs. I find it hard to believe that the man's mental state can be played like a yo-yo, and if it can't be we'll have to go with whatever statistical magic Chileogu can put together."

Alana gave a little snort that she'd probably meant to be a laugh. "Hard to know which way to hope, isn't it?"

"Yeah." I hesitated for a second, running the duty arrangements over in my mind. "Look, why don't you take the next few days off, at least until the next point. Sarojis can take your shift up here."

"That's all right," she sighed. "I—if it's all the same with you, I'd rather save any offtime until later. Rik will . . . need my help more then."

"Okay," I told her. "Just let me know when you want it and the time's yours."

We continued on our slow way, and with each cascade point I became more and more convinced that Lanton really would be able to guide us through those last two critical points. His accuracy for the first four maneuvers was a solid hundred percent, and on the fifth maneuver we got to within point zero two percent of the computer's previous reading by deliberately jockeying the *Dancer* back and forth until Bradley's image pattern was exactly as Lanton remembered it. After that even Matope was willing to be cautiously optimistic; and if it hadn't been for one small cloud hanging over my head I probably would have been as happy as the rest of the passengers had become.

The cloud, of course, being Bradley.

I'd been wrong about how much his improvement had been due to the drugs Lanton had been giving him, and every time I saw him that ill-considered line about playing his mind like a yo-yo came back to haunt me. Slowly, but very steadily, Bradley was regressing back toward his original mental state. His face went first, his expressions beginning to crowd each other again as if he were unable to decide which of several moods should be expressed at any given moment. His eyes took on that shining, nervous look I hated so much: just occasionally at first, but gradually becoming more and more frequent, until it seemed to be almost his norm. And yet, even though he certainly saw what was happening to him, not once did I hear him say anything that could be taken as resentment or complaint. It was as if the chance to save twenty other

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lives was so important to him that it was worth any sacrifice. I thought occasionally about Alana's comment that he'd never before had a sense of dignity, and wondered if he would lose it again to his illness. But I didn't wonder about it all that much; I was too busy worrying about Alana.

I hadn't expected her to take Bradley's regression well, of course—to someone with Alana's wing-mending instincts a backsliding patient would be both insult *and* injury. What I wasn't prepared for was her abrupt withdrawal into a shell of silence on the issue which no amount of gentle probing could crack open. I tried to be patient with her, figuring that eventually the need to talk would overcome her reticence; but as the day for what Lanton described as "minor surgery" approached, I finally decided I couldn't wait any longer. On the day after our sixth cascade point, I quit being subtle and forced the issue.

"Whatever I'm feeling, it isn't any concern of yours," she said, her fingers playing across the bridge controls as she prepared to take over from me. Her hands belied the calmness in her voice: I knew her usual check-out routine as well as my own, and she lost the sequence no fewer than three times as I watched.

"I think it is," I told her. "Aside from questions of friendship, you're a member of my crew, and anything that might interfere with your efficiency is my concern."

She snorted. "I've been under worse strains than this without falling apart."

"I know. But you've never buried yourself this deeply before, and it worries me."

"I know. I'm . . . sorry. If I could put it into words—" She shrugged helplessly.

"Are you worried about Bradley?" I prompted. "Don't forget that, whatever Lanton has to do here, he'll have all the resources of the Swedish Psychiatric Institute available to undo it."

"I know. But . . . he's going to come out of it a different person. Even Lanton has to admit that."

"Well . . . maybe it'll wind up being a change for the better."

It was a stupid remark, and her scornful look didn't make me feel any better about having made it. "Oh, come *on*. Have you *ever* heard of an injury that did any real good? Because that's what it's going to be—an injury."

And suddenly I understood. "You're afraid you won't like him afterwards, aren't you? At least not the way you do now?"

"Why should that be so unreasonable?" she snapped. "I'm a damn fussy person, you know—I don't like an awful lot of people. I can't afford to . . . to lose any of them." She turned her back on me abruptly, and I saw her shoulders shake once.

I waited a decent interval before speaking. "Look, Alana, you're not in any shape to stay up here alone. Why don't you go down to your cabin and pull yourself together, and then go and spend some time with Bradley."

"I'm all right," she mumbled. "I can take my shift."

"I know. But . . . at the moment I imagine Rik needs you more than I do. Go on, get below."

She resisted for a few more minutes, but eventually I bent her sense of duty

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far enough and she left. For a long time afterwards I just sat and stared at the stars, my thoughts whistling around my head in tight orbit. What *would* the effect of the new Bradley be on Alana? She'd been right—whatever happened, it wasn't likely to be an improvement. If her interest was really only in wing-mending, Lanton's work would merely provide her with a brand-new challenge. But I didn't think even Alana was able to fool herself like that any more. She cared about him, for sure, and if he changed too much that feeling might well die.

And I wouldn't lose her when we landed.

I thought about it long and hard, examining it and the rest of our situation from several angles. Finally, I leaned forward and keyed the intercom. Wilkinson was off-duty in his cabin; from the time it took him to answer he must have been asleep as well. "Wilkinson, you got a good look at the damage in Lanton's neural whatsis machine. How hard would it be to fix?"

"Uh . . . well, that's hard to say. The thing that spit goop all over the Ming-metal coil was a standard voltage regulator board—we're bound to have spares aboard. But there may be other damage, too. I'd have to run an analyzer over it to find out if anything else is dead. Whether we would have replacements is another question."

"Okay. Starting right now, you're relieved of all other duty until you've got that thing running again. Use anything you need from ship's spares—" I hesitated— "and you can even pirate from our cargo if necessary."

"Yes, sir." He was wide awake now. "I gather there's a deadline?"

"Lanton's going to be doing some ultrasound work on Bradley in fifty-eight hours. You need to be done before that. Oh, and you'll need to work in Lanton's cabin—I don't want the machine moved at all."

"Got it. If you'll clear it with Lanton, I can be up there in twenty minutes."

Lanton wasn't all that enthusiastic about letting Wilkinson set up shop in his cabin, especially when I wouldn't explain my reasons to him, but eventually he gave in. I alerted Kate Epstein that she would have to do without Wilkinson for a while, and then called Matope to confirm the project's access to tools and spares.

And then, for the time being, it was all over but the waiting. I resumed my examination of the viewport, wondering if I were being smart or just pipe-dreaming.

Two days later—barely eight hours before Bradley's operation was due to begin—Wilkinson finally reported the neural tracer was once again operational.

"This better be important," Lanton fumed as he took his place at the dining room table. "I'm already behind schedule in my equipment set-up as it is."

I glanced around at the others before replying. Pascal and Chileogu, fresh from their latest attempt at making sense from their assortment of plots, seemed tired and irritated by this interruption. Bradley and Alana, holding hands tightly under the table, looked more resigned than anything else. Everyone seemed a little gaunt, but that was probably my

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imagination—certainly we weren't on anything approaching starvation rations yet. "Actually, Doctor," I said, looking back at Lanton, "you're not in nearly the hurry you think. There's not going to be any operation."

That got everyone's full attention. "You've found another way?" Alana breathed, a hint of life touching her eyes for the first time in days.

"I think so. Dr. Chileogu, I need to know first whether a current running through Ming metal would change its effect on the ship's real rotation."

He frowned, then shrugged. "Probably. I have no idea how, though."

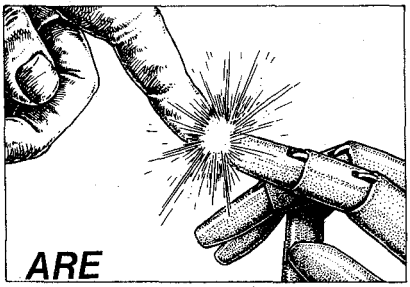
A good thing I'd had the gadget fixed, then. "Doesn't matter. Dr. Lanton, can you tell me approximately when in the cascade point your neural tracer burned out?"

"I can tell you exactly. It was just as the images started disappearing, right at the end."

I nodded; I'd hoped it was either the turning on or off of the field generator that had done it. That would make the logistics a whole lot easier. "Good. Then we're all set. What we're going to do, you see, is reenact that particular maneuver."

"What good will *that* do?" Lanton asked, his tone more puzzled than belligerent.

"It should get us home." I waved towards the outer hull. "For the past two days we've been moving toward a position where the galactic field and other parameters are almost exactly the same as we had when we went through that point—providing your neural tracer is on and we're heading back toward Taimyr. In another two days we'll turn



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around and get our velocity vector lined up correctly. Then, with your tracer running, we're going to fire up the generator and rotate the same amount—by gyro reading—as we did then. *You*—" I leveled a finger at Lanton— "will be on the bridge during that operation, and you will note the exact configuration of your cascade images at that moment. Then, *without shutting off the generator*, we'll rotate *back* to zero; zero as defined by your cascade pattern, since it may be different from gyro zero. At that time, I'll take the Ming metal from your tracer, walk it to the number one hold, and stuff it into the cargo shield; and we'll rotate the ship again until we reach your memorized cascade pattern. Since the physical and real rotations are identical in that configuration, that'll give us the real angle we rotated through the last time—"

"And from *that* we can figure the angle we'll need to make going the other direction!" Alana all but shouted.

I nodded. "Once we've rotated back to zero to regain our starting point, of course." I looked around at them again. Lanton and Bradley still seemed confused, though the latter was starting to catch Alana's enthusiasm. Chileogu was scribbling on a notepad, and Pascal just sat there with his mouth slightly open. Probably astonished that he hadn't come up with such a crazy idea himself. "That's all I have to say," I told them. "If you have any comments later—"

"I have one now, Captain."

I looked at Bradley in some surprise. "Yes?"

He swallowed visibly. "It seems to me, sir, that what you're going to need is a set of cascade images that vary a lot, so that the pattern you're looking for is a distinctive one. I don't think Dr. Lanton's are suitable for that."

"I see." Of course; while Lanton had been studying Bradley's images, Bradley couldn't help but see his, as well. "Lanton? How about it?"

The psychiatrist shrugged. "I admit they're a little bland—I haven't had a very exciting life. But they'll do."

"I doubt it." Bradley looked back at me. "Captain, I'd like to volunteer."

"You don't know what you're saying," I told him. "Each rotation will take twice as long as the ones you've already been through. *And* there'll be two of them back to back; *and* the field won't be shut down between them, because I want to know if the images drift while I'm moving the coil around the ship. Multiply by about five what you've felt afterwards and you'll get some idea what it'll be like." I shook my head. "I'm grateful for your offer, but I can't let more people than necessary go through that."

"I appreciate that. But I'm still going to do it."

We locked eyes for a long moment . . . and the word *dignity* flashed through my mind. "In that case, I accept," I said. "Other questions? Thank you for stopping by."

They got the message and began standing up . . . all except Alana. Bradley whispered something to her, but she shook her head and whispered back. Reluctantly, he let go of her hand and followed the others out of the room.

"Question?" I asked Alana when we were alone, bracing for an argument over the role I was letting Bradley take.

"You're right about the extra stress

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staying in Colloton space that long will create," she said. "That probably goes double for anyone running around in it. I'd expect a lot more vertigo, for starters, and that could make movement dangerous."

"Would you rather Bradley had his brain scorched?"

She flinched, but stood her ground. "My objection isn't with the method—it's with who's going to be bouncing off the *Dancer*'s walls."

"Oh. Well, before you get the idea you're being left out of things, let me point out that *you're* going to be handling bridge duties for the maneuver."

"Fine; but since I'm going to be up anyway I want the job of running the Ming metal back and forth instead."

I shook my head. "No. You're right about the unknowns involved with this, which is why *I'm* going to do it."

"I'm five years younger than you are," she said, ticking off fingers. "I also have a higher stress index, better balance, and I'm in better physical condition." She hesitated. "And I'm not haunted by white uniforms in my cascade images," she added gently.

Coming from anyone else, that last would have been like a knife in the gut. But from Alana, it somehow didn't even sting. "The assignments are non-negotiable," I said, getting to my feet. "Now if you'll excuse me, I have to catch a little sleep before my next shift."

She didn't respond. When I left she was still sitting there, staring through the shiny surface of the table.

"Here we go. Good luck," were the last words I heard Alana say before the intercom was shut down and I was alone in Lanton's cabin. Alone, but not for long: a moment later my first doubles appeared. Raising my wrist, I keyed my chrono to stopwatch mode and waited, ears tingling with the faint ululation of the Colloton field generator. The sound, inaudible from the bridge, reminded me of my trainee days, before the *Dancer* . . . before Lord Hendrik and his foolheaded kid. . . . Shaking my head sharply, I focused on the images, waiting for them to begin their one-dimensional allemande.

They did, and I started my timer. With the lines to the bridge dead I was going to have to rely on the image movements to let me know when the first part of the maneuver was over; moving the Ming metal around the ship while we were at the wrong end of our rotation or—worse—while we were still moving would probably end our chances of getting back for good. Mindful of the pranks cascade points could play on a person's time sense, I'd had Pascal calculate the approximate times each rotation would take. Depending on how accurate they turned out to be, they might simply let me limit how soon I started worrying.

It wasn't a pleasant wait. On the bridge, I had various duties to perform; here, I didn't have even that much distraction from the ghosts surrounding me. Sitting next to the humming neural tracer, I watched the images flicker in and out, white uniforms dos-à-dosing with the coveralls and the gaps.

Ghosts. *Haunted*. I'd never seriously thought of them like that before, but now I found I couldn't see them in any other way. I imagined I could see know-

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ing smiles on the liner captains' faces, or feel a coldness from the gaps where I'd died. Pure autosuggestion, of course . . . and yet, it forced me for probably the first time to consider what exactly the images were doing to me.

They were making me chronically discontented with my life.

My first reaction to such an idea was to immediately justify my resentment. I'd been cheated out of the chance to be a success in my field; trapped at the bottom of the heap by idiots who ranked political weaselcraft higher than flying skill. I had a *right* to feel dumped on.

And yet . . .

My watch clicked at me: the first rotation should be about over. I reset it and waited, watching the images. With agonizing slowness they came to a stop . . . and then started moving again in what I could persuade myself was the opposite direction. I started my watch again and let my eyes defocus a bit. The next time the dance stopped, it would be time to move Lanton's damn coil to the hold and bring my ship back to normal.

My ship. I listened to the way the words echoed around my brain. *My ship*. No liner captain owned his own ship. He was an employee, like any other in the company; forever under the basilisk eye of those selfsame idiots who'd fired me once for doing my job. The space junk being sparser and all that aside, would I *really* have been happier in a job like that? Would I have enjoyed being caught between management on one hand and upper-crusty passengers on the other? Enjoyed, hell—would I have *survived* it? For the first time in ten years I began to wonder if perhaps

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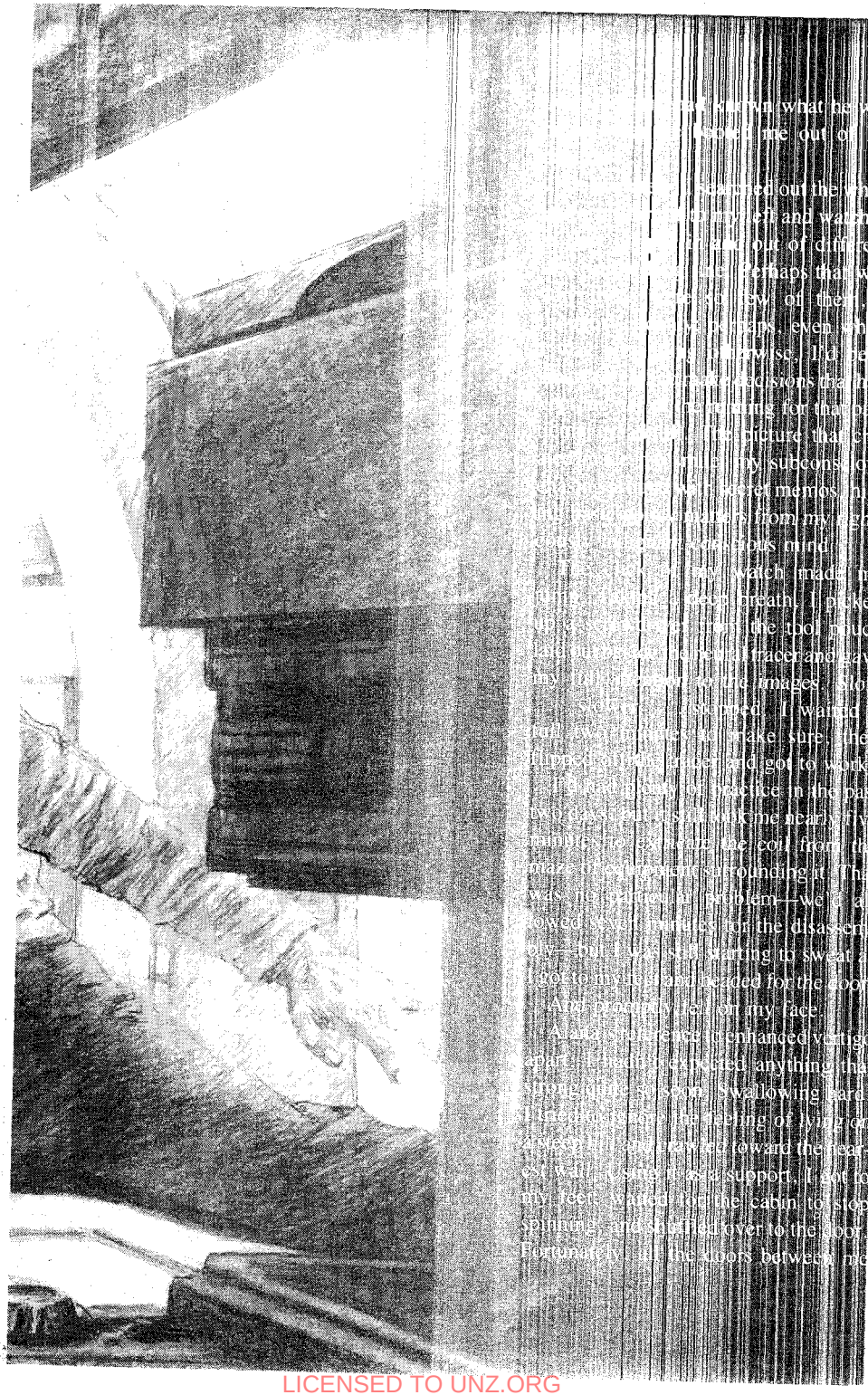

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and One Hold had been locked open, so I didn't have to worry about getting to the release. Still shuffling, I maneuvered through the opening and started down the corridor, moving as quickly as I could. The trip—fifteen meters of corridor, a circular stairway down, five more meters of corridor, and squeezing through One Hold's cargo to get to the shield—normally took less than three minutes. We'd allowed ten; but already I could see that was going to be tight. I kept my eyes on the wall beside me and concentrated on moving my feet . . . which was probably why I was nearly to the stairway before I noticed the kaleidoscope dance my cascade images were doing.

While the ship was at rest.

I stopped short, the pattern shifts ceasing as I did so. The thing I had feared most about this whole trick was happening: moving the Ming metal was changing our real angle in Colloton space.

I don't know how long I leaned there with the sweat trickling down my forehead, but it was probably no more than a minute before I forced myself to get moving again. There were now exactly two responses Alana could make: go on to the endpoint Lanton had just memorized, or try and compensate somehow for the shift I was causing. The former course felt intuitively wrong, but the latter might well be impossible to do—and neither had any particular mathematical backing that Chileogu had been able to find. For me, the worst part of it was the fact that I was now completely out of the decision process. No matter how fast I got the coil locked away, there was no way I was going to make it back up two flights of stairs to the bridge. Like everyone else on board, I was just going to have to trust Alana's judgment.

I slammed into the edge of the stairway opening, nearly starting my downward trip headfirst before I got a grip on the railing. The coil, jarred from my sweaty hand, went on ahead of me, clanging like a muffled bell as it bounced to the deck below. I followed a good deal more slowly, the writhing images around me adding to my vertigo. By now, the rest of my body was also starting to react to the stress, and I had to stop every few steps as a wave of nausea or fatigue washed over me. It seemed forever before I finally reached the bottom of the stairs. The coil had rolled to the middle of the corridor; retrieving it on hands and knees, I got back to the wall and hauled myself to my feet. I didn't dare look at my watch.

The cargo hold was the worst part yet. The floor was swaying freely by then, like an ocean vessel in heavy seas, and through the reddish haze surrounding me, the stacks of boxes I staggered between seemed ready to hurl themselves down upon my head. I don't remember how many times I shied back from what appeared to be a breaking wave of crates, only to slam into the stack behind me. Finally, though, I made it to the open area in front of the shield door. I was halfway across the gap, moving again on hands and knees, when my watch sounded the one-minute warning. With a desperate lunge, I pushed myself up and forward, running full tilt into the Ming-metal wall. More from good luck than anything else, my free hand caught the handle; and as I

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fell backwards the door swung open. For a moment I hung there, trying to get my trembling muscles to respond. Then, slowly, I got my feet under me and stood up. Reaching through the opening, I let go of the coil and watched it drop into the gap between two boxes. The hold was swaying more and more violently now; timing my move carefully, I shoved on the handle and collapsed to the deck. The door slammed shut with a thunderclap that tried to take the top of my head with it. I hung on just long enough to see that the door was indeed closed, and then gave in to the darkness.

I'm told they found me sleeping with my back against the shield door, making sure it couldn't accidentally come open.

I was lying on my back when I came to, and the first thing I saw when I opened my eyes was Kate Epstein's face. "How do you feel?" she asked.

"Fine," I told her, frowning as I glanced around. This wasn't my cabin. . . . With a start I recognized the humming in my ear. "What the hell am I doing in Lanton's cabin?" I growled.

Kate shrugged and reached over my shoulder, shutting off the neural tracer. "We needed Dr. Lanton's neural equipment, and the tracer wasn't supposed to be moved. A variant of the mountain/Mohammed problem, I guess you could say."

I grunted. "How'd the point maneuver go? Was Alana able to figure out a correction factor?"

"It went perfectly well," Alana's voice came from my right. I turned my head, to find her sitting next to the door. "I think we're out of the woods now,

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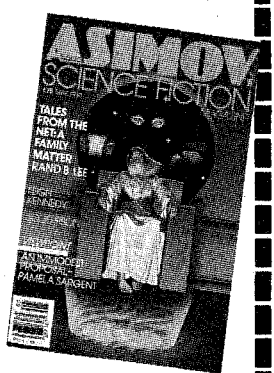

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Pall—that four-point-four physical rotation turned out to be more like nine point one once the coil was out of the way. If Chileogu's right about reversibility applying here, we should be back in our own universe now. I guess we won't know for sure until we go through the next point and reach Earth."

"Is that nine point one with or without a correction factor?" I asked, my stomach tightening in anticipation. We might not be out of the woods quite yet.

"No correction needed," she said. "The images on the bridge stayed rock-steady the whole time."

"But . . . *I* saw them shifting."

"Yes, you told us that. Our best guess —excuse me; *Pascal's* best guess—is that you were getting that because you were moving relative to the field generator, that if you'd made a complete loop around it you would've come back to the original cascade pattern again. Chileogu's trying to prove that mathematically, but I doubt he'll be able to until he gets to better facilities."

"Uh-huh." Something wasn't quite right here. "You say I *told* you about the images? When?"

Alana hesitated, looked at Kate. "Actually, Captain," the doctor said gently, "you've been conscious quite a bit during the past four days. The reason you don't remember any of it is that the connection between your short-term and long-term memories got a little scrambled—probably another effect of your jaunt across all those field lines. It looks like that part's healed itself, though, so you shouldn't have any more memory problems."

"Oh, great. What sort of problems *will* I have more of?"

"Nothing major. You might have balance difficulties for a while, and you'll likely have a mild migraine or two within the next couple of weeks. But indications are that all of it is very temporary."

I looked back at Alana. "Four days. We'll need to set up our last calibration run soon."

"All taken care of," she assured me. "We're turning around later today to get our velocity vector pointing back toward Taimyr again, and we'll be able to do the run tomorrow."

"Who's going to handle it?"

"Who do you think?" she snorted. "Rik, Lanton, and me, with maybe some help from Pascal."

I'd known that answer was coming, but it still made my mouth go dry. "No way," I told her, struggling to sit up. "You aren't going to go through this hell. I can manage—"

"Ease up, Pall," Alana interrupted me. "Weren't you paying attention? The real angle doesn't drift when the Ming metal is moved, and that means we can shut down the field generator while I'm taking the coil from here to One Hold again."

I sank back onto the bed, feeling foolish. "Oh. Right."

Getting to her feet, Alana came over to me and patted my shoulder. "Don't worry," she said in a kinder tone. "We've got things under control. You've done the hard part; just relax and let us do the rest."

"Okay," I agreed, trying to hide my misgivings.

It was just as well that I did. Thirty-

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eight hours later Alana used our last gram of fuel in a flawless bit of flying that put us into a deep Earth orbit. The patrol boats that had responded to her emergency signal were waiting there, loaded with the fuel we would need to land.

Six hours after that, we were home.

They checked me into a hospital, just to be on the safe side, and the next four days were filled with a flurry of tests, medical interviews, and bumpy wheelchair rides. Surprisingly—to me, anyway—I was also nailed by two media types who wanted the more traditional type of interview. Apparently, the *Dancer*'s trip to elsewhere and back was getting a fair amount of publicity. Just how widespread the coverage was, though, I didn't realize until my last day there, when an official-looking CompNote was delivered to my room.

It was from Lord Hendrik.

I snapped the sealer and unfolded the paper. The first couple of paragraphs —the greetings, congratulations on my safe return, and such—I skipped over quickly, my eyes zeroing in on the business portion of the letter:

As you may or may not know, I have recently come out of semi-retirement to serve on the Board of Directors of TranStar Enterprises, headquartered here in Nairobi. With excellent contacts both in Africa and in the so-called Black Colony chain, our passenger load is expanding rapidly, and we are constantly on the search for experienced and resourceful pilots we can entrust them to. The news reports of your recent close call brought you to my mind again after all these years, and I thought you might be interested in discussing—

A knock on the door interrupted my reading. "Come in," I called, looking up.

It was Alana. "Hi, Pall, how are you doing?" she asked, walking over to the bed and giving me a brief once-over. In one hand she carried a slender plastic portfolio.

"Bored silly," I told her. "I think I'm about ready to check out—they've finished all the standard tests without finding anything, and I'm tired of lying around while they dream up new ones."

"What a shame," she said with mock sorrow. "And after I brought you all this reading material, too." She hefted the portfolio.

"What is it, your resignation?" I asked, trying to keep my voice light. There was no point making this any more painful for either of us than necessary.

But she just frowned. "Don't be silly. It's a whole batch of new contracts I've picked up for us in the past few days. Some really good ones, too, from name corporations. I think people are starting to see what a really good carrier we are."

I snorted. "Aside from the thirty-six or whatever penalty clauses we invoked on this trip?"

"Oh, that's all in here too. The Swedish Institute's not even going to put up a fight—they're paying off everything, including your hospital bills and the patrol's rescue fee. Probably figured Lanton's glitch was going to make them look bad enough without them trying to chisel us out of damages, too." She hesitated, and an odd expression flick-

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ered across her face. "Were you really expecting me to jump ship?"

"I was about eighty percent sure," I said, fudging my estimate down about nineteen points. "After all, this is where Rik Bradley's going to be, and you . . . rather like him. Don't you?"

She shrugged. "I don't know *what* I feel for him, to be perfectly honest. I like him, sure—like him a lot. But my life's out there" —she gestured skyward— "and I don't think I can give that up for anyone. At least, not for him."

"You could take a leave of absence," I told her, feeling like a prize fool but determined to give her every possible option. "Maybe once you spend some real time on a planet, you'd find you like it."

"And maybe I wouldn't," she countered. "And when I decided I'd had enough, where would the *Dancer* be? Probably nowhere I'd ever be able to get to you." She looked me straight in the eye and all traces of levity vanished from her voice. "Like I told you once before, Pall, I can't afford to lose *any* of my friends."

I took a deep breath and carefully let it out. "Well. I guess that's all settled. Good. Now, if you'll be kind enough to tell the nurse out by the monitor station that I'm signing out, I'll get dressed and we'll get back to the ship."

"Great. It'll be good to have you back." Smiling, she disappeared out into the corridor.

Carefully, I got my clothes out of the closet and began putting them on, an odd mixture of victory and defeat settling into my stomach. Alana was staying with the *Dancer*, which was certainly what I'd wanted . . . and yet, I couldn't help but feel that in some ways her decision was more a default than a real, active choice. Was she coming back because she wanted to, or merely because we were a safer course than the set of unknowns that Bradley offered? If the latter, it was clear that her old burns weren't entirely healed; that she still had a ways—maybe a long ways—to go. But that was all right. I may not have had the talent she did for healing bruised souls, but if time and distance were what she needed, the *Dancer* and I could supply her with both.

I was just sealing my boots when Alana returned. "Finished? Good. They're getting your release ready, so let's go. Don't forget your letter," she added, pointing at Lord Hendrik's CompNote.

"This? It's nothing," I told her, crumpling it up and tossing it toward the waste basket. "Just some junk mail from an old admirer."

Six months later, on our third point out from Prima, a new image of myself in liner captain's white appeared in my cascade pattern. I looked at it long and hard . . . and then did something I'd never done before for such an image.

I wished it lots of luck. ■

● Anyone who has begun to think places some portion of the world in jeopardy.

John Dewey

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THE LAUNCH LOOP

Keith H. Lofstrom

A novel way to get around the expense of rockets for routine space travel.

A Business Trip, 2005

The elevator ride from the ground has taken almost an hour, and the ride to NBC-1, a geosynchronous transmission satellite serving the eastern seaboard, will take another four. That isn't nearly as long as the airplane trip from New York, but at least the plane had windows, and you weren't strapped in and "plumbed." The small cabin that you share with five other passengers has no portholes; you have just a video screen built into the seat in front of you. This is your first trip, so you are tuned into the outside camera system. The screen shows the "Can" you are in, the cradle carrying it, and the slender cables disappearing into the black sky above and the ocean below. The woman strapped into the seat beside you is reading technical reports on her screen, which is configured as a terminal. The man in front is playing a video game. They are apparently experienced space travelers.

There is a queasy feeling in your stomach as the Can slows its ascent; you are nearing west station, now less than three kilometers above you. West station is the terminus of the 120-kilometer-high elevator system, and the start

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of the 2000-kilometer-long acceleration track that will hurl you into space. As you get closer, you begin to make out details: the light, open structure of west station, its long support pillar, and the small observation cabin on top, bristling with radar and communication antennas. The cradle rack above you holds two other Cans similar to yours, streamlined and covered with heat shields. The rack also holds eight box-like cargo containers, probably from the container ship you saw this morning on your way in.

If the carriers above you are standard five-metric-ton vehicles, your Can should be lowered over the ribbon and launched in about 30 minutes. This is happening to the top vehicle now. The crane has lifted it out of its cradle and is lowering it over the track, carefully positioning it so the magnets in the channel on its belly are on top of the high-speed ribbon. The container starts moving towards the east, picks up speed rapidly, and vanishes into the rising sun.

Getting Out of the Hole

Moving from the Earth's surface to useful orbits requires momentum and energy. By Newton's laws, the momentum must be removed from something else, whether it is rocket exhaust, a beam of light, the atmosphere, or the Earth itself. Energy can be applied in several ways, but the amount of energy that must be turned into payload energy is constant. If the energy is applied less efficiently, more is needed to begin with. This change of momentum and energy can be expressed as a change in velocity, or delta v.

Vehicles are launched to higher orbits in elliptical transfer orbits. At the bottom of the ellipse—at the point closest to the Earth—the vehicle is moving faster than circular orbital velocity at that altitude. A very high delta v is necessary to put the vehicle into this faster orbit. At the top of the transfer orbit (apogee), the height of the vehicle's circular orbit destination, the vehicle is moving slower than circular orbital velocity. Velocity has been lost as the vehicle traveled up out of the gravity well. More delta v must be added to make the orbit circular, but this velocity change is small compared to the delta v needed at launch.

The velocity change at launch time is the largest and most expensive. From the Earth's equator to the Moon, the delta v at the start of the transfer orbit is 10.6 kilometers per second. The transfer orbit to geosynchronous altitudes requires 9.95 kilometers per second of delta v.

An Earth launch system should accelerate a vehicle to transfer orbit velocity without crushing acceleration or dropping it back to the ground. A low acceleration requires a long acceleration path. Accelerating a vehicle to 10.6 kilometers per second at 3 g's requires an acceleration path 1900 kilometers long, almost 5 percent of the Earth's circumference.

The energy is proportional to the mass and the velocity squared; for a one-kilogram mass, a delta v of 10.6 kilometers per second requires the addition of 56 million joules. This looks smaller if measured electrically; 3.6 million joules equals one kilowatt-hour (1000 watts for

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one hour, and a watt is one joule per second), and one kilowatt-hour costs about 4 cents in the Northwest. That comes to about 60 cents' worth of electricity, and that's why electrically powered launch systems are starting to get a lot of attention.[1]

Present rocket launch systems cost much more than this, because of their enormous complexity and the vast amounts of fuel they consume. Most of the thrust a rocket generates lifts the fuel, tanks, and engines it will need later in the flight. A fully loaded space shuttle orbiter weighs 100 metric tons (a metric ton is 2205 pounds, a little more than an English short ton). The assemblage of tanks and solid boosters that lifts from Kennedy Space Center weighs over 2000 metric tons, most of which is fuel. The orbiter, surely one of the most marvelous machines ever built, is nevertheless an incredibly expensive vehicle. Optimistic estimates suggest more than two months between each shuttle re-use, a slow way to pay back a multibillion-dollar investment. The maximum payload is 30 metric tons to low Earth orbit, or 5 metric tons to geosynchronous orbit, a tiny fraction of the launch weight. A shuttle launch costs more than 30 million dollars, and this doesn't include the purchase of the shuttle itself, or the expensive shuttle ground support systems left over from the Apollo program. A greatly expanded space program based on rockets may prove much too costly.

The idea of a fixed structure on Earth or in space, electromagnetically driven and capable of handling many vehicles per hour, is not a new one. The skyhook was suggested by Yuri Artsutanov in 1960, and independently by Isaacs *et al* in 1966.[2] The skyhook is a long cable reaching up from the Earth's surface far into space, its downward weight balanced by centrifugal force as it follows the rotation of the Earth. Artsutanov's idea has been expanded on by others, with tapered cables, rotating cables, and other refinements intended to lower the mass of the system or ease construction.[3] Incredibly strong materials are required that will not be commercially available for many years, making these systems impractical at present. Most designs must be built from orbit, which requires a large existing space launch capability as well.

Mass drivers use moving magnetic fields to accelerate vehicles equipped with electrically conducting coils or shells. In the November 1979 *Analog* Roger Arnold and Donald Kingsbury suggested an orbiting mass driver for vehicle capture, the Spaceport.[4] The Spaceport is an orbiting platform 500 kilometers long that captures vehicles from the Earth or high orbit along its length. Energy is extracted from the velocity difference between the vehicle and the Spaceport and stored in rotating coils. The vehicle is accelerated to the same speed as the Spaceport, and the Spaceport changes velocity slightly. The stored energy may be used to eject vehicles from the Spaceport. The Spaceport has a mass of 50,000 metric tons and must be assembled in orbit, while the vehicles it handles are too small (230 kilograms, or 500 pounds) to transport human beings or larger machines. A Spaceport that can move people must be much larger. While this system may

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be the most economical in the long term, it would be very expensive to ship up with rockets.

Earth-based mass drivers[5] are capable of reaching orbital velocities, but the Earth's atmosphere is a major problem. If vehicles are launched horizontally, they must travel through hundreds of kilometers of atmosphere before reaching space, and the air drag is enormous. If launched vertically, the accelerator must be very tall and the g forces are much too high for people or complex machinery. Such a system might be useful for some raw materials, but only if people and machinery get into orbit by some other means.

Such accelerators also must handle enormous pulsed power. A five-metric-ton vehicle accelerating at only three g's and moving at eight kilometers per second requires 1.2 billion watts of power from the segment of the accelerator immediately around it. This is the power level of a large power generating plant, and this power-handling capability must be repeated many times down the accelerator. Accelerators such as this could be very expensive.

A good Earth-based launch system should be built from the ground up, operate in vacuum, and deliver energy and momentum to the vehicle without expensive power-handling circuitry.

By Your Own Bootstraps

A ball tossed into the air, a stream of water from a hose, and a planet in its orbit are all governed by Newton's Laws, and follow paths that balance the external forces on them with their own accelerations. An orbit can be viewed as a balance between centrifugal acceleration and gravity; if the centrifugal force is higher than the gravitational force, the orbiting body moves upwards. If a stream of material moves faster than orbital velocity, it will also move upwards, unless extra downwards force is added. This force could be provided by stationary weight somehow "hung" on the stream.

The centrifugal force on the stream is proportional to the velocity squared. A stream moving twice as fast as orbital velocity generates a centrifugal force four times that of gravity, and such a stream could support the weight of a stationary mass three times its own mass. Altitude actually improves the lifting action, which can be used to support long, light structures far above the Earth's surface.

If the moving stream is an iron strip or ribbon, it will be attracted to a magnetic field. Consider an electromagnet with long pole faces parallel to the direction of the moving iron ribbon, as shown in Figure 1. The magnetic flux travels through the coils and into one pole. It then passes up through the gap into the ribbon, across it, and back down through the other gap to the other pole, completing the magnetic circuit. The poles are attracted to the ribbon, attempting to close the gap. The control electronics sense the spacing and adjust the current in the control coils to change the field, and thus the upwards force on the poles.

The magnets, electronics, and poles are called the "track." The track does not need to move with the ribbon. If the magnetic field between the track and

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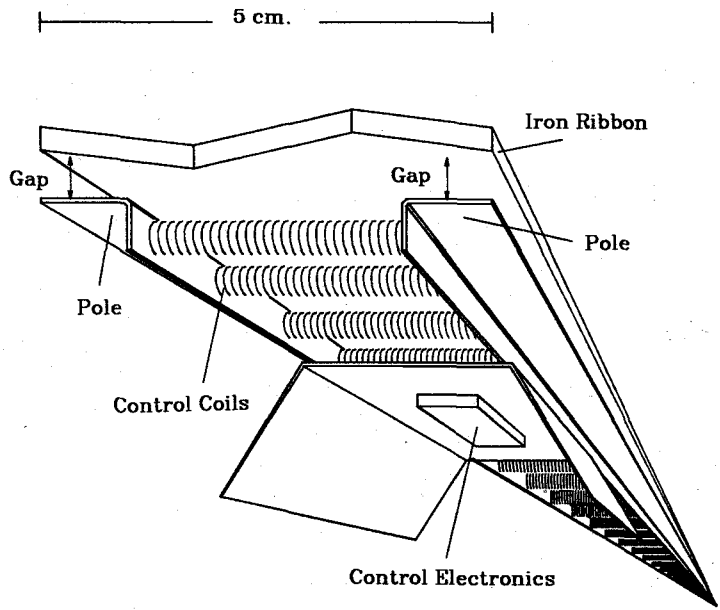

Figure 1—A cross section of the ribbon and track.

ribbon is uniform, the ribbon can move at very high speed without friction between it and the stationary track, even while the ribbon supports the track against gravity. This is a form of "magnetic levitation," which is being considered for high-speed trains, supporting the train cars without the rolling friction of wheels.

We will use an iron ribbon 5 centimeters wide and 2.6 millimeters thick (about 2 inches by 0.1 inches) with a mass of 1 kilogram per meter. If the ribbon is moving at 12 kilometers per second relative to the Earth's surface, and at an altitude of 120 kilometers above it, the upwards centrifugal force is capable of supporting 2.35 kilograms of mass per meter against gravity. The ribbon itself has a mass of 1 kilogram per meter. The centrifugal force can thus support the ribbon and a stationary mass of 1.35 kilograms per meter.

If the poles are 1 centimeter wide, the force per area on the poles will be equivalent to the weight of 70 kilograms per square meter. This force can be generated with a small magnetic field of about 0.04 tesla (a metric unit of magnetic field strength). For comparison, the Earth's magnetic field is 0.0001 teslas, a good permanent magnet generates about 1 tesla, and superconducting magnets can go beyond 20 teslas. This small

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field is deflecting the ribbon around the radius of the Earth. To deflect the ribbon around a tighter radius, more force is needed.

If a fast-moving stream is deflected by a small angle, a force is generated in opposition, proportional to the angle times the mass per length times the velocity squared. To deflect the moving ribbon described above by an angle of 1 degree, a force of 260 metric tons is needed. This deflection does not stretch or strain the ribbon, or change its speed; the force simply changes the stream's direction. In this way a very small, fast-moving ribbon can support huge loads.

A stream of matter can also carry enormous power, equal to half the mass per length times the velocity *cubed*. A 1 kilogram-per-meter ribbon moving at 12 kilometers per second carries 864 billion watts, more than three times present U.S. electrical capacity; yet an iron ribbon of that size can easily travel through a 10-centimeter pipe.

A high-speed iron strip can transmit power, support heavy loads, and suspend stationary mass at high altitudes. These features make possible the Launch Loop, a new kind of electromagnetic launch system.

The Launch Loop

The Launch Loop, illustrated in Figure 2, is a very large, stationary, gossamer structure built around a 6000-

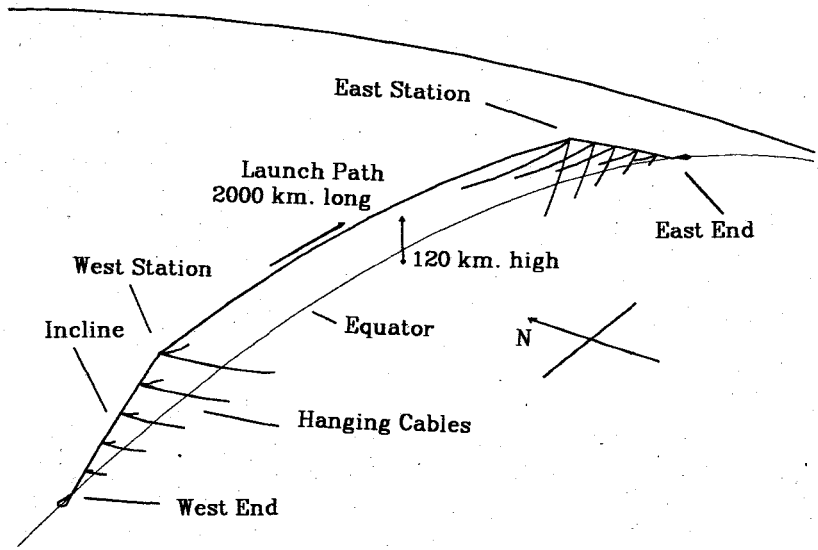

Figure 2—A side view of the Launch Loop. Most cross sections are centimeters or millimeters, making the structure virtually invisible from a distance.

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kilometer-long recirculating loop of iron ribbon moving at 12 kilometers per second. The structure is 3000 kilometers long and 120 kilometers high. This seems gigantic, but the mass per length is only 5 to 10 kilograms per meter, and most cross sections can be measured in centimeters. The entire above-ground weight of the Launch Loop is 35,000 metric tons, about the weight of a large ship. It may be constructed from modest quantities of materials that are now commercially available.

The ribbon follows a path shaped like one side of a sawhorse, parallel to the equator. The ribbon travels up one leg (the west incline), across the top (the launch path), and down the east incline. At the bottom of the east end, it is deflected back to return along the same path. At the west end, it is deflected again to complete the loop. The ribbon completes one circuit of the Loop, 6000 kilometers, in 8 minutes.

The 2000-kilometer-long launch path in the center of the Loop accounts for most of its length. Fortunately, it is also the cheapest part of the system. This section is 120 kilometers high, and runs parallel to the equator. It is supported by the centrifugal force generated by the moving ribbon. The ribbon runs both directions through this section, with the "forward" ribbon moving from west to east and the "return" ribbon running east to west. A track is suspended underneath each ribbon, consisting of magnet structures, control electronics, position sensors, stabilizing cables, and parachutes to protect the track if the system falls down. The return ribbon and track run a few hundred meters below the forward track, and the two tracks are coupled with thin cables. The launch path is at high altitude to minimize air drag on the ribbon and the vehicles launched from it.

The weight of the launch path is entirely supported by the centrifugal acceleration on the ribbon; if it were extended at the ends, it could circle the Earth without support. In practice, small stabilizing forces are required to control the system. A very small deflection of the ribbon at west station could result in the ribbon leaving the track at east station.

The "east" and "west" stations are at either end of the launch path. The stations are built on 1200-meter-long, curved sections of electromagnets that deflect the ribbons about 7 degrees downwards to provide the upwards force needed to support the station. Long Kevlar® cables to the ground stabilize the station and relieve horizontal forces. The stations are equipped with vehicle storage racks, repair bays, communication systems, and large, fast motors that adjust cable tensions. The elevators on the west station haul the vehicles up from the surface for launching. Each station weighs 2500 metric tons, and the cables are tensioned to a total of 1200 metric tons. West station is illustrated in Figure 3 [next page].

Before and after the stations are the inclines, two sections sloping down to the Earth's surface at a 7- to 20-degree angle. The inclines connect the launch path to structures on the surface. The inclines travel through the atmosphere, so a vacuum sheath is required to protect the ribbon from air friction. Horizontal

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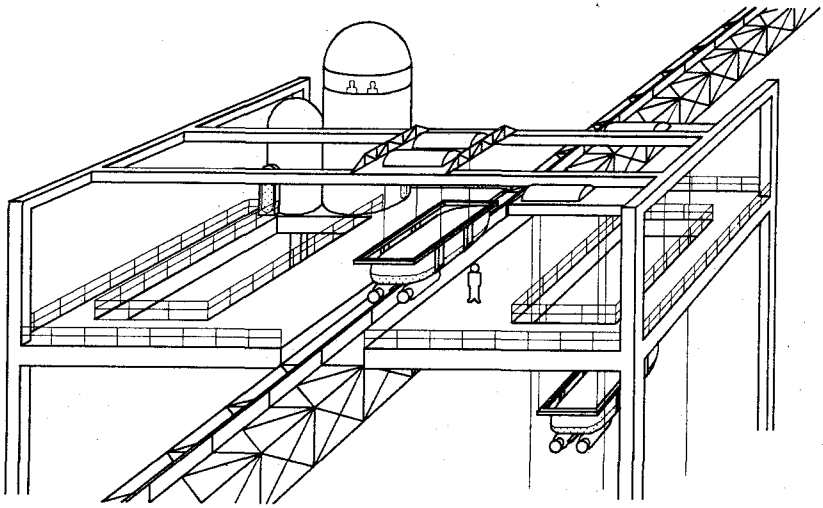

Figure 3—West station, showing a vehicle being loaded onto the track.

forces and wind stresses are relieved by Kevlar® cables running diagonally to the ground. The inclines have a mass of about 5 kilograms per meter, and curve more than the Earth's surface, drooping near the top.

The ribbon reaches the bottom of the inclined section at a 20-degree angle, and is forced to horizontal with electromagnets on a curved ramp. This ramp changes height by 600 meters, and may be cheaper if built in a narrow tunnel under the surface, resulting in the "S" shaped kink shown at the bottom of the incline in Figure 4. Traveling parallel to the Earth's surface, the ribbon passes through a 2-kilometer-long, high-efficiency linear motor. Four of these linear motors, two on each end of the Launch Loop, restore energy removed by friction and vehicle launches.

Once the ribbon is horizontal, and restored to speed by the motors, it must be deflected 180 degrees and sent back the other way. A force of nearly 30,000 metric tons is necessary to do this, equal to two times the ribbon mass per length times the velocity squared. This will be done with the "D" magnets, a magnetic track like that of the launch path, but much more powerful. The ribbon is rotated so that the flat surface is pointing sideways, and the flat surface is pulled toward the magnets, deflecting the ribbon in the horizontal plane. The magnets deflect the ribbon in a 20-kilometer-diameter semicircle, with a force of about 1.5 metric tons per meter and a magnetic field of about 2 tesla. These magnets will weigh about 200 metric tons, and their windings will consume 60 megawatts. They must be firmly an-

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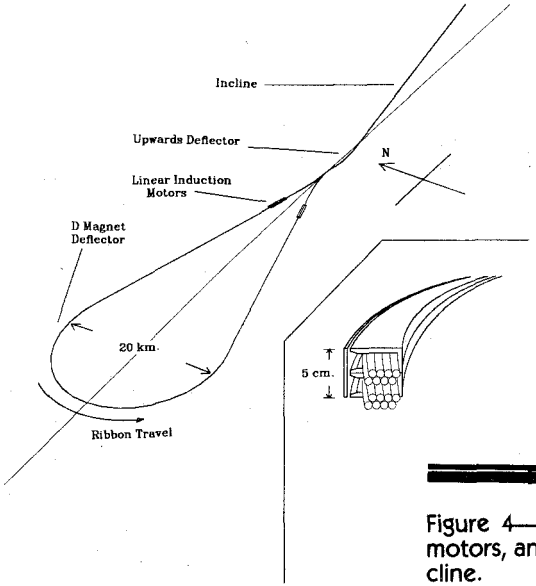

Figure 4—The west end deflectors, motors, and the start of the west incline.

chored to the ground to absorb the deflection stress. With a deflector at either end of the Loop, the Earth itself can be viewed as a giant structural member, holding the ends of the Loop together.

The ribbon changes height from the top to the bottom of the Loop; as it travels downwards, its speed increases by 100 meters per second, causing the ribbon to stretch by 0.8%. Iron will fracture with this much strain, so the ribbon will be built in 1-meter segments, with sliding joints between them. Although this weakens the ribbon along its length, the ribbon is never under tension or compression during normal operation.

The Launch Loop should be located along the equator for optimum launching and weather conditions. Most of the interesting places in space are on or near the plane of the equator and are most easily reached from there. Violent storms and high winds are aided by Coriolis forces, which result from the Earth's rotation. These forces are minimized at the equator, causing milder winds.

Launching Vehicles

The Launch Loop is a large stable structure, reaching from the Earth's surface into space. How is this device used to launch vehicles?

There are two common forms of magnetic levitation:[6] one is based on the attraction of magnets to other magnets or ferromagnetic materials such as iron; the other uses the repulsion between a magnet and induced currents in a conductor.

The attractive levitation process the-

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oretically consumes no power, but is unstable and requires power for stabilizing electromagnets and control circuitry. This process is used in the track support and end deflection magnets, where large forces must be generated with minimum power dissipation.

Vehicles are supported and driven by repulsive levitation. Repulsive levitation uses the eddy currents induced in a conductor by a rapidly changing magnetic field. The eddy currents generate a reverse magnetic field, pushing the originating magnet away. The eddy currents dissipate heat, which appears mechanically as drag between the conductor and the generating magnet. Drag is desirable between the ribbon and the vehicle, as it provides the force to accelerate the vehicle.

This version of the Loop is designed to launch 5-metric-ton vehicles. Payload containers have strips of magnets on their bottom side designed to generate a lift of up to 5 metric tons and a drag of 15 metric tons, accelerating them at 3 g's. Rocket motors on the bottom of the payload container will provide additional delta v when the vehicle is at the top of its orbit, at apogee. The center of mass of the payload, container, and rockets is on axis with the ribbon, with stability provided by magnetic damping and small rocket thrusters.

Re-enterable payload containers, as shown in Figure 5, are equipped with a lifting shell, a heat shield, and parachutes for reentry of human cargo if the Loop fails. Insurable, inanimate payloads will not need this protection, and will probably burn up if they accidentally re-enter.

The heat removal by the ribbon from

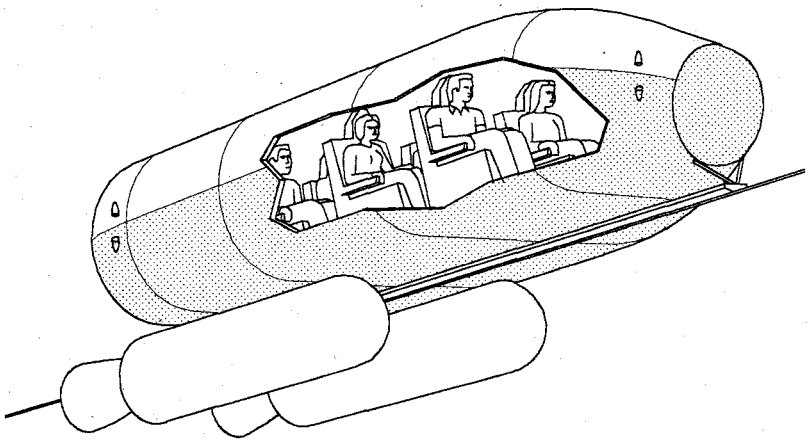

Figure 5—A typical five-metric-ton passenger vehicle, with magnets, rocket motors for apogee orbit insertion, and a heat shield for accidental reentry.

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the vicinity of the vehicle determines the maximum force the vehicle can put on the ribbon. A drag force of 15 metric tons results in almost 2 billion watts of heat carried from a vehicle near rest; this heats the ribbon from 400 to 620 degrees centigrade. Iron loses its magnetic properties above 770 degrees centigrade, its Curie temperature.

Launching a 5-metric-ton vehicle to 10 kilometers per second removes 600 billion joules of ribbon kinetic energy, of which 350 billion joules is turned into heat, for an energy efficiency of 41%. The initial Loop will be driven by a 500-megawatt gas turbine power plant. Sixty megawatts will be used for deflection magnets, and 40 megawatts for auxiliary equipment, leaving 400 megawatts to drive the motor. About 70 megawatts will be lost to air friction and drag in the ribbon, leaving 330 megawatts to restore the energy used to launch vehicles. This can restore the energy used to launch a 5-metric-ton vehicle in about 30 minutes. This is equivalent to 240 metric tons per day, or 87,000 metric tons per year.

The energy storage capacity of the Loop will allow it to launch at high rates for short periods with less than full power plant capacity. Power plants may be brought on and off line as necessary; the Loop can store energy for days. More power plants can be added, and more vehicles launched per hour, until the Loop reaches its thermal limit. This Loop limits at 4 billion watts (4 gigawatts), allowing the launch of 115 metric tons per hour, or 1 million metric tons per year. It may be years before even one Launch Loop is used at full capacity.

System Startup

The system is stable once it's going, and it can launch a lot of payload, but how is it started up? The ribbon must be started on the ground from a standstill, and accelerated without stretching it too much. The ribbon sections normally above the atmosphere are now in it, and must be protected from air drag. The east and west stations must be lifted to altitude.

The Loop is started flat on the ground. The ribbon is levitated at rest by the D magnets, and is held *underneath* the inverted tracks in the launch path. The launch path is surrounded by a temporary vacuum sheath, to be stripped off later. When the ribbon is first started moving, it is stretched by the pull of the motors and compressed after leaving them. This is a slow process, as the ribbons cannot be pulled too hard without breaking the joints between ribbon segments.

Once the ribbon is moving fast enough, the electrical generators are brought up to full power. To get the 6000-metric-ton ribbon moving at 12 kilometers per second requires 120 gigawatt-hours of energy. The Loop will need almost two weeks to get up to speed if this energy is put in at a 400-megawatt rate.

When the ribbon is finally moving at 12 kilometers per second, the stations and the launch path may be raised from the surface. At the start, the inclines have zero length, and the launch path is 500 kilometers longer than normal. The anchoring cables on the stations pull

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them toward the center, and the structure slowly rises. During this time, air traffic must be guided over or under the Loop; once the Loop is up, only the ends will pose a hazard to navigation.

As the system rises, the launch path in the center gets shorter and the inclined sections get longer. At the stations, the inclines are extended by welding together new sheath over them, while sheath is cut away from the launch path. This is performed in long vacuum chambers running the length of the stations; while the ends of the chambers are not tightly sealed, they are long and equipped with powerful pumps, so that a high vacuum can be maintained where the sheath is opened.

The Loop may have to be re-erected a few times per year. Control failure on too many segments of track, ultra-high winds, meteoroid impact, vehicle magnet failures, and other problems may cause Loop failure. The major portions of the system must survive the loss of the ribbon, the kinetic energy of the ribbon must be safely dissipated, and the system should be quickly restorable to service.

The moving ribbon stores 120 million kilowatt-hours. This amount of energy would be produced in heat by the combustion of 10,000 metric tons of oil (modern oil tankers carry 550,000 metric tons). If the Launch Loop fails, this energy is lost, and the ribbon should be dumped out in a harmless way. Releasing it at the top of the Loop will throw it away from the Earth at escape velocity, creating a cloud of space junk in solar orbit. From the inclined sections of the D magnets it will be thrown into the atmosphere or onto the ground, in line of sight with the Loop. The Loop should be operated in unpopulated areas. A lost ribbon can only land near the equator, and must be slowed to just below orbital velocity by air friction to do so. This much air friction would harmlessly vaporize the ribbon.

System Costs

The Launch Loop can launch vehicles very cheaply, but how much will it cost to build one? As the first prototype of a new kind of launch system, it could be very expensive. Fortunately, however, most of the main components are commercially available or are easily mass produced, and their costs may be calculated.

The beginning power plant will use 11 United Technologies 56-megawatt dual FT4 gas-turbine power plants, costing $77 million. Structural material costs include $5 million for 200 metric tons of Union Carbide Thornel® carbon fiber and $25 million for 1000 metric tons of DuPont Kevlar® aramid fiber. The magnets and control systems will use $3 million for 1500 metric tons of copper wire and $16 million for 400 metric tons of formed Alnico 8 magnets. The control electronics and motor drivers will cost around $60 million. These identified costs total less than $200 million.

Unknown costs include sheath and track manufacturing, and the upward deflectors on the ends. If the Loop is built on land, many square kilometers of land must be purchased; if at sea, floats and anchoring cables are needed. Vacuum pumps, storage tanks, security

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systems, housing, and a myriad of other details must be included.

The first commercial Launch Loop may cost 1 billion dollars (a guess), and be used at 30% capacity with a 500-megawatt generator (26,000 metric tons per year). If this system was paid back in one year as a high-risk venture it would cost $50 per gross kilogram (including 6 cents per kilowatt-hour for turbine fuel). Later, launching 750,000 metric tons per year with 4 gigawatts power capacity, 5-year amortization, $9 billion capital cost, and 1.3 cents per kilowatt-hour fuel cost, the cost per gross kilogram is $3. At this cost, labor and vehicle systems will probably dominate net payload cost. Total Launch Loop system cost will probably be well below that of Earth-to-high-orbit rocket systems.

Conclusions

The Launch Loop described here was designed for launching 5-metric-ton vehicles to geosynchronous, LaGrange, and lunar destinations, but other applications are possible. Increasing ribbon speed to 16 kilometers per second lowers near-Earth efficiency, but increases Loop range to Mercury and Jupiter.

Loops may be constructed off Earth, for launching from other bodies or vehicle capture in orbit. For example, the 1500-meter-per-second delta v needed for geosynchronous orbit circularization could be provided by a capture ribbon 120 kilometers long, accelerating vehicles at 1 g. This would make apogee boost motors unnecessary, allowing more net mass per vehicle. Momentum may be restored to the capturing system with high-efficiency ion engines, or payload capture from higher orbits.

Loop structures may even be built in evacuated pipes on the Earth's surface, and used to transmit power. A ribbon with a mass of 1 kilogram per meter moving at 8 kilometers per second carries 250 billion watts of power, and perhaps 20 billion watts can be added or removed as necessary. Energy can be put into the ribbon, transmitted 5000 kilometers, and taken back out with less than 1% loss.

We are now building a 3.7-meter-across, racetrack-shaped, 170-meter-per-second model of the Launch Loop, and are planning larger experiments. It may take 15 to 20 years to scale up to a commercial Loop. At present, this project is funded out of our salaries and savings, and is being put together with volunteer labor; motivated, technically competent volunteer help would be appreciated. A more extensive paper is available on request from the author at P.O. Box 1538, Portland OR 97207.

A Business Trip, Continued

The wait is nearly over; the overhead crane is moving over to lift your Can off its cradle and onto the ribbon. The ribbon is so thin, it's hard to see, extending into the distance. You are reminded of the Loop on NBC-1, which you are going up to help complete. With the new orbital Loop, vehicles can be captured from Earth without onboard rocket engines, pulled up to the speed necessary for geosynchronous orbit by the Loop and the mass of the space platform itself. You will be installing the large ion engines that launched ahead

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of you, which will be used to restore the momentum removed by arriving vehicles.

This is only a temporary measure. Materials are being accumulated on the Moon for a lunar base, which will use its own surface-based Launch Loop for shipping ore from the surface to the smelters and foundries being built at L-5. Those materials will be launched back down to NBC-1, and used for building more antennas; the extra momentum of these cargos will compensate for lost momentum from Earth shipments. When that happens, NBC will sell their ion engines to U.S. Steel, who is planning a mining expedition to the asteroids. You are wondering if you will follow them out.

There is a slight jolt as the Can is lowered onto the ribbon and slowly released by the crane. The ribbon in front of the Can is heated to dim incandescence; perhaps that is only your imagination, but the force starting to push you back into your seat is not. The end of west station passes by, and it feels like you are on your back with someone on top of you; strange but not painful.

In six minutes the acceleration will end, followed by four hours of free fall. Thousands have taken this path before you, billions more will follow; but you still feel, and rightly so, like a pioneer. ■

ABOUT THE AUTHOR

Keith Lofstrom was born September 5, 1953, and received an MSEE from U. C. Berkeley in 1975. He works as an integrated circuit design engineer at Tektronix in Beaverton, Oregon. He is a member of L-5, AAS, AIAA, BIS, NSI, and SSI. He believes governments are for gravity wells. He plans to be permanently living and working in space before the year 2000.

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● There has been opposition to every innovation in the history of man, with the possible exception of the sword.

Benjamin Dana

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On Gaming

Dana Lombardy

The Best Fantasy Game of 1982, as chosen by the Academy of Adventure Gaming Arts and Design, is a real surprise.

Sherlock Holmes, Consulting Detective by Sleuth Publications Ltd. (2527 24th Street, San Francisco, CA 94110) isn't a fantasy game in the usual sense of swords and sorcery. But because the game features a famous fictional character, *Sherlock Holmes* was classified as a fantasy rather than a historical game.

The object is to solve any of 10 cases provided and then compare your sleuthing with Holmes's deductions of the crime. Here's where you get the chance to match your deductive skills with investigative fiction's most famous detective.

The game can be played any of three ways: solitaire, by two competing players, or by a group trying to solve the crimes as a team. You can finish a solution in an evening, or you can tackle the problem in a more leisurely fashion.

Sherlock Holmes comes in a three-ring binder with a "Clue Book" that contains all the clues for the 10 different cases. Included separately are a Case Book with the 10 cases and solutions; a Quiz Book for comparing your solution to Holmes's; a small eight-page rules booklet; a London Directory giving locations of persons related to the cases; a reference map of Holmes's London of the late 1890's; and a Newspaper Archive of various editions of *The Times of London,* reporting relevant information on the cases buried among pages of news.

The company recently released Volume II of the game. Called *The Mansion Murders,* this supplement contains a Clue Book with five new cases and a Quiz Card with the solutions to these cases, all punched to fit in the original three-ring binder.

Separate materials include a Case Book with detailed solutions to the five crimes, a Newspaper Archive folder with certain editions of *The Times of London,* and reference maps showing the grounds of the mansion and upstairs and downstairs floor plans.

Fans of the Sherlock Holmes novels should appreciate the care and detail Sleuth Publications has lavished on the design of the game. There are numerous quotes by Holmes throughout, and the presentation of the cases captures much of the flavor of the period.

To give you an idea of how the game works, let's look at *The Mansion Murders.*

At the beginning of the Clue Book is an informal tour of the mansion, with rooms described and keyed for reference. The four cases that use the mansion (a fifth doesn't) are formatted this way: the London Clue Points are first, followed by the Mansion Directory which details the household and staff for that particular case, including the rooms they occupy and any room changes from the main key. The case description comes next, followed by the Mansion Clue Points.

(continued on page 100)

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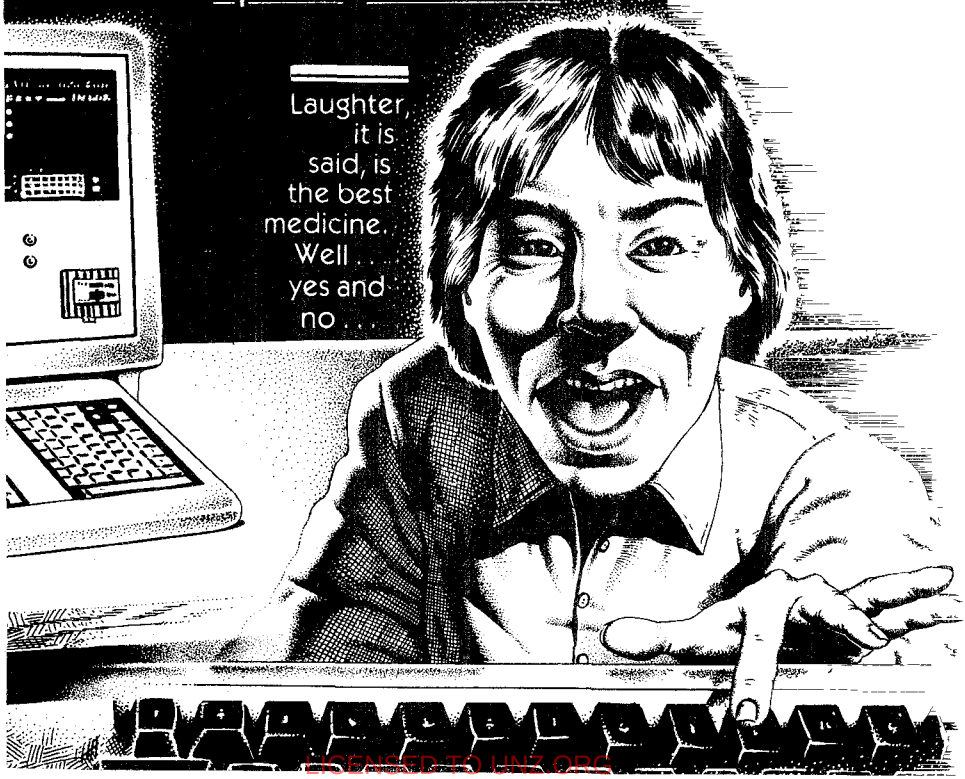
NVOLUNTARY MAN'S LAUGHTER

Spider Robinson



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Some of the people who hang out at Callahan's Place aren't all there—this is widely known. But a few of them aren't there at all.

Well, obviously they *are* there, at least in a sense. Otherwise I'd be offering you a paradox, and Sam Webster is the only Doc we have here at Callahan's bar. But if a customer cannot be seen, heard, felt, smelt, or dealt a hand of cards, if he casts no shadow, empties no glass, and never visits the men's room—can he really be said to be there? Even if you're having a conversation with him at the time?

We have two or three regulars at Callahan's who fit that nondescription: old and dear friends of ours who have never set foot in the place. One of them, for instance, is a ghost, and I'll tell you about him another time, when we've both had a couple more drinks. But the one I'd like to tell you about right now is a human being—and while I have seen him once, I don't think I ever will again.

It was a Punday Night last year when the Cheerful Charlies showed up looking glum. This was quite unusual, enough so to engage my attention when I caught sight of them both—for the Cheerful Charlies have, quite literally, earned their name.

Doc Webster had already won the Punday competition—something he does with about the same consistency with which Mr. T wins arguments. The only way the Doc can possibly lose is if all possible puns on a given topic have been exhausted before it's his turn—and far more often, when everyone else has come up empty, the Doc still has four or five up his sleeve. You might say that our chronic asteismus is iatrogenic . . . but of course you probably wouldn't.

Like now, for instance: the evening's topic had been one of those so broad as to seem inexhaustible—"animals"—and owl give ewe the gnus: most of us cats and chicks were falcon hoarse as we toad the lion and shrew our gl-asses into the fire in sheepish cabitchulation. But Dog Websteer was still game, cheerfoal as venison the springtime, a weaselly grin on his puss that got my goat.

"—always puzzled me," he was saying, "that females of all species except the human seem, at best, utterly disinterested in mating. Most will actively resist it until compelled by glandular pressure, and even then seem to derive little enjoyment from the business. Why, I wondered, should human females alone be blessed with the capacity to enjoy the inevitable?"

A good question. I'd always wondered that myself.

"The answer turns out to be simple. Man is a *bald* ape."

"Oh God," Shorty Steinitz groaned. "Even for you, Doc, that's an *awful* pun."

The Doc blinked and then grinned. "You misunderstand me, sir—for once the pun was unintentional. No, I mean that man is relatively hairless—whereas, through some sadistic quirk of nature, most other male animals are endowed with hairy penises. A cat's penis, for instance, is covered with short, spiky hairs—*which face in the wrong direction.*"

Murmurs of surprise and sympathy ran around the tavern; a few ladies winced.

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"Small wonder, then," the Doc went on, folding his hands across his expansive belly, "that a female cat doesn't much feel like putting out—for any tom dickin' hairy."

The horrified silence stretched out for nearly five seconds . . . and then we awarded him the Supreme Accolade: as one we left our drinks where they stood, held our noses, and fled screaming into the night.

It was a nice night out there; I found that I was in no hurry to follow the rest of the gang back inside. My drink was perfectly safe where it was, and I wanted a few minutes alone with myself. I was feeling . . . well, "troubled" would be too strong a word, but I don't know a word for the shading between there and "content." Just one of those mild itches of the soul that a man doesn't particularly feel like sharing with all his friends, a passing impulse to toot for a few bars on the old self-pity horn.

It was, perhaps inevitably, just as I was finishing a contemplative cigarette and saying "Sometime again," to the full moon that the Cheerful Charlies drove up in their '54 Thunderbird and wedged it into the confusion. (By honored custom, the parking lot at Callahan's always looks as though a platoon of psychopaths had turned a game of Bumper Cars into an unresolvable snarl and wandered off. A half-dozen times a night we all have to pile outside to let somebody out, and it doesn't inconvenience us in the least.) Just the sight of their splendid old heap cheered me up some.

Neither of them is named Charlie; that's their professional designation and job description. They cheer people up for a living. You may have seen their ad in the paper:

DEPRESSED? Gamble a little time on The Cheerful Charlies. $25 if we cheer you up, nothing at all if we don't: you decide! 24-hr. emergency service available (rates double from 10 PM to 8 AM). Call CHE-ERUP for an appointment: what have you got to lose?

And, of course, their business card sums it up even more succinctly: HAVE FUN, WILL TRAVEL.

They did not found the business. That was done by Tom Flannery a few years back. Tom was one of the most infectiously cheerful men I ever met, and he had a certain natural advantage in cheering people up: at the time he founded his enterprise, Tom had about eight months to go on the nine-month sentence his doctors had given him (and did in fact eventually die on schedule almost to the day). He didn't talk about it much, but it made a terrific hole-card for dealing with cases of intractable self-pity. How many people have the gall to be depressed around a smiling fellow who says he'll be dead before your tax-return comes back? Tom hadn't expected to make money at his job—but to his surprise he left a sizable estate.

The present Cheerful Charlies began as clients of Tom's. Each was depressed by the same two things: both were chronically unemployed, and both bore names of the sort that parents ought to be prevented by law or by vigilante violence from giving to their children. The Moore family pronounced their name

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"More," and saw fit to name their son Les; while the Gluehams, with a malignant case of the cutes, named their daughter Merry.

The coincidence of names was just too much for Tom Flannery to resist, I guess. He convinced them both that one of the best ways to cheer yourself up is to try and cheer other people up (it worked for him, after all), and took them both on as apprentices, thus solving their unemployment problem. As he must have hoped, they fell in love—and when they married, they solved the question of does-she-take-his-last-name by swapping even-steven. With irresistible appropriateness, she became Merry Moore and he became Les Glueham. They carried on Tom's business after he died, and the story of their names itself is sometimes sufficient to get a client smiling.

Les and Merry have no set routine, but rather a whole spectrum of techniques which they tailor to fit the individual case. They are wise and warm people, with professionally tuned empathic faculties, and they seem to have made a remarkably comfortable marriage. One of their early cases, for instance, was a lonely old widower who had lost all his joy in living: after all their best efforts had failed, Merry and Les talked it over, decided that it might help and that in this specific case it probably couldn't hurt—and then Merry took the old gentleman to bed. It did the trick, and since then they have (very infrequently) had occasion to use love-making as cheer-up therapy, singly or together. It has always worked so far, and they always refuse their fee in such cases. This is both to avoid breaking laws, and to motivate themselves to exhaust all other possibilities before resorting to Old Reliable-But-Risky; it inhibits the human tendency to rationalize oneself into the sack. But some cases of depression will yield to no other medicine.

And if even *that* doesn't work, Merry and Les bring 'em to Callahan's Place.

But they didn't appear to have a client with them tonight. They got out of the T-Bird, a little slowly I thought, and came my way. Merry was carrying something that looked like a big piece of stereo gear, and Les seemed to have a hardcover book with him. "Hey, Jake—what's the matter?" Merry called to me.

"God's teeth," I said under my breath. Then aloud: "From twenty feet across a parking lot by moonlight you can tell I've got something on my mind. From what? The echo of an expression I was wearing before you pulled up? You people are incorrigibly good at what you do, you know that?"

"Ouch," Les said softly.

They had almost reached me by now, and the third thing I saw was that Les's hardcover was a boxed videotape, and the second thing I saw was that Merry's stereo was a VTR, and the first thing I saw was that Les and Merry were—astonishingly, most uncharacteristically—miserably depressed. Their expressions, their stride, their body language, all said that they were so far down that up was for astronomers; they had, to quote a song of mine, the Industrial Strength Blues.

"Jesus Christ on a Moped, what's the matter with you two?" An unpleasant

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thought began to form. "Oh hell, you didn't lose one, did you?" That happened a year ago, a sleeping-pill job, and it took us all about a week to put the Cheerful Charlies back together again. It is the occupational risk, and a failure rate as low as one a year means that the Cheerfuls are supernaturally good at what they do. (They have to be; there is no malpractice insurance for their racket.)

"No," Merry answered, "not yet anyway."

"Well, *tell* me about it."

"You tell us yours first."

"Mine? Hey, on a scale of ten I'm a point two five and you guys are up in the eights—and I think it's a log scale, like the Richter."

"Come on, give. If it's a simple one, great: we could use the confidence right now."

I shrugged. "Okay. I was just going a few rounds with envy."

"Of whom?" Merry asked, setting the VTR down on the Datsun I was using for a bench.

"The Doc."

"Ah."

"I like to make people laugh. So I troll for the best jokes I can find, make up the best ones I can devise, work on my timing, try to work the audience into it and use their feedback—and it works pretty well, most times they laugh, or groan, or whatever I was looking for. The Doc could recite his Social Security Number, deadpan, and lay 'em on the floor. Dammit, I tell better jokes than he does, I even think I tell 'em better—and he gets more laughs. With his incredibly tortuous set-ups and his corny voice and his Paleozoic punchlines, we all fall down laughing. Even me! He's just an intrinsically funny man—and I'm just a guy who tries to be funny."

"And the worst of it," Les said, "is that he's such a totally nice guy, you can't even dislike him for it."

"Bullseye."

Merry grinned, a ghost of her usual grin. "This is ironic." She and Les shared a glance.

I shook my head ruefully. "For you guys, no doubt. So okay: in the words of Mr. Ribadhee to the Hip Ghand, 'Straighten me, 'cause I'm ready.' "

"Jake," Les said, "a few years ago you lent us a novel called *Lord of Light*, by Roger Zelazny. Remember it?"

"Sure. An SF novel about a world patterned after Hindu mythology."

"Right—and then along came Buddha to kick over the applecart. Now, remember how the people who had become 'gods' were each able, at will, to take on an Aspect and raise up an Attribute?"

"Yama could become Death, and drink your life with his eyes, Mara's Aspect was Illusion, and his Attribute was to cloud your mind with a gesture. And so forth."

"You've got it. Well, it's like that with the Doc. His Aspect is Humor. In a figurative, but very real sense, Doc Webster *is* Humor—at least when he chooses to take on his Aspect. And his Attribute is the ability to make you wet yourself laughing. Envying him is like envying a flower because it never needs deodorant."

"Huh," I said. "I think I get you. It's silly to envy the gods."

"Especially when you are one."

"Eh?"

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"Jake," Merry said, "when was the last time someone interrupted you while you were singing?"

"Well . . ." I couldn't bring such an instance to mind. People do tend to quiet down when I take my guitar out of her case.

Les did his uncanny Martin Mull imitation. " 'Remember the Great Folk Music Scare of the Fifties?' " he quoted. " 'That shit almost caught on.' Jake, haven't you noticed that you're about the only folksinger left on Long Island who can still find regular work? Don't you know why you don't need electronics and a thousand watts and a rhythm section to get gigs? Man, when you pick up Lady MacBeth and put her across your lap and open your mouth, you take on your Aspect—and when you wring her neck and coax sound out of her sounding-box and sing along with her, you're raising up your Attribute. You take people out of themselves, for as long as you choose to go on singing. Doc Webster is Humor, Jake, and you are Music. Don't you know that?"

I thought it over—and suddenly grinned. "How did you guys ever get the name Cheerful Charlies?"

"Maybe because we own the complete works of Walt Kelly," Les hazarded. "Come on, let's go inside."

"Wait—what about *your* problem? Cheering-up ought to be like breast-feeding, you know, mutually satisfactory."

"Tit for tot?" Merry asked innocently.

Les mock-glared at her. "I think our problem should be taken inside," he said. "We need a group head on this one."

So we went in and took chairs at the bar.

Mike Callahan came ambling over, wiping his big hands on his apron, smiling broadly when he saw the Cheerfuls. He took out one of the *non*-safety stick matches he imports from Canada, struck it on his stubbly chin, and put a fresh light on one of the stunted malodorous cigars he imports from Hell. "Well, if it ain't the Beerful Barleys! What'll it be, folks?"

I finished the beer I had left on the counter and answered for all three of us. "Bless us, father, for we have thirst."

Callahan nodded and made up three portions of God's Blessing. It is called Irish Coffee by the vulgar, and I'm told there are actually places where they don't sugar the rim of the glass before making it—but we who drink at Callahan's Place have a proper respect for the finer things in life. "Here you go, folks." I could tell from his expression that Mike had picked up on the Cheerfuls' state of mind, and wanted to know what they were down about. But . . . look, I've been hanging out at Callahan's for a good many years now. But if I walked in tomorrow night with a toilet bowl tattooed on my forehead, Mike Callahan would fail to notice it unless and until I brought the matter up. Mike likes that people should open up and talk about their troubles in his bar—and so he has given standing orders to Fast Eddie the piano player that anyone caught asking snoopy questions is to be discouraged with a blackjack.

Occasionally, though, he will allow himself to lead a witness. "So how's

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life been treating you two?'' he asked as he Blessed us.

Merry answered obliquely. ''Mike, is that babble box in the back room still operational?''

The big Irishman blinked. ''Well, yeah. I use it for a monitor on my microprocessor.''

Callahan's Place has been fully wired for cable television—but the only times in my memory that the tube has ever been hooked up for viewing and switched on were coronations, assassinations, space shots, and the final episode of ''M*A*S*H.'' Its operation requires either the unanimous vote of all customers present, or—even more rarely—whim of Mike Callahan.

Merry lifted the VTR from her lap and set it on the bar. ''Would you whip it out, Mike? We want to call a meeting.''

The red-headed barkeep was as mystified and curious as I was—I could tell—but he just nodded.

Well, of course, by the time the boob tube was hot and the VTR connected, the Cheerfuls had the undivided attention of everyone in the room. Callahan passed around fresh drinks for those who needed them, and we sat back to see what the Cheerfuls had for us.

''Folks,'' Merry said, popping the tape into the deck and laying her finger on the PLAY button, ''we've got a client we don't know what to do with, and we'd like to ask your help.''

There was a ragged chorus of reply. ''Sure,'' ''Of course,'' ''You got it,'' and, from Long-Drink McGonnigle in the corner, ''Whyn't you just bring him or her around?''

Merry looked pained. ''Ordinarily we would. But this case is a little unique, and we thought it might be advisable if we prepared you all first. You may not be able to help us, and if you can't it'll hurt, worse than not trying.''

''I am offended,'' the Drink said, only half-kidding. ''This here is *Callahan's Place*. Did you need to prepare us before you brought around that guy with no jaw?''

''No,'' Merry conceded, ''and you were all splendid. But this is different.''

''We just have to be sure,'' Les said. ''This guy is right on the edge. So here's the deal: the tape Merry is about to run lasts about two minutes. If you can all watch it all the way through in dead silence—without a single sound—we'll bring him around tomorrow night. Deal?''

''This tape is of your client?'' Callahan asked.

''That's right.''

''Piece of cake,'' Long-Drink stated. ''Fire it up.''

Merry nodded, and pushed down the PLAY button—

—and we all fell down laughing.

She stopped the tape, and the laughter chopped off raggedly, leaving a stunned silence.

She reached to start it again, and we redoubled our determination not to laugh . . . and within five seconds the last of us had collapsed again in helpless, horrified laughter.

She stopped and started it once more, and this time I bit my tongue hard enough to draw blood, and again I could *not* prevent myself from whooping with laughter. Nor could any of us—Callahan included.

* * *

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"You see why your problem outside seemed so ironic to us, Jake," Merry murmured, stopping the tape for the last time and popping it up out of the machine. I nodded, thunderstruck.

Did you ever find yourself in a situation where it is hideously inappropriate to laugh—and you just can't help yourself? It is a horrid sensation, much like shitting your pants. Now I began to understand why the Cheerfuls weren't. Imagine if Doc Webster literally *couldn't* help being funny . . .

"What de fuck was dat?" Fast Eddie breathed.

"That," Doc Webster said grimly, "was the worst case of Tourette's Syndrome I ever saw in my life."

"Doc," Long-Drink said indignantly, "are you trying to tell me that that was some kind of *disease?* What kind of a guy do you think God is, anyway?"

So the Doc told us all about Tourette's Syndrome. Nobody knows what causes it. You may have seen Dick Cavett doing a public-service commercial about it, late at night when the network has run out of paying customers. I had—and recognized the symptoms almost as quickly as the Doc had—but it was hard to imagine that there could be an unhappier victim anywhere in the world than the Cheerfuls' client; he was afflicted with an extremely exaggerated version of the syndrome.

The symptoms of Tourette's include involuntary twitching, grunting, and barking. No sufferer is happy with it—but this young fellow just happened to have a recurring twitch that looked *exactly* like what might be produced by the greatest comedian in the world going flat out for a laugh, and his grunts sounded *precisely* like a gorilla making love, and his constant barking was not only *uncannily* canine, but issued from a face which looked more like a cocker spaniel's than even early-period Ringo Starr did. The overall effect was devastatingly—diabolically—hilarious; the three symptoms, funny enough separately, heterodyned together.

"His name is Billy Walker, and he's eighteen years old," Les said. "The disease came on at age fifteen—it usually hits the young—and the usual palliatives, Haldol and so forth, don't help him in the slightest. Unlike most sufferers, he can't suppress or control his symptoms, even for a short time. This tape was made by a couple of specialists from Johns Hopkins, and they had to leave the room while the camera was rolling or they would have spoiled the audio track. For the last two years Billy has lived shut up in a little cottage in Rocky Point, supported by his parents. The only friend he's had since the onset was a blind and deaf guy he met at Hopkins. They lived together for a year. The guy died two weeks ago, and Billy saw our ad and got in touch with us."

"And now I don't know what we're going to do for him," Merry finished sadly.

"How'd he get in touch with you?" I asked.

Merry looked even sadder. "I hate to admit this. He called us three times on the phone, and each time we just assumed that it was a gag call. The third time, Les got mad and told him off—so he sent us a letter."

"How could he hold a pen steady enough with a twitch like that?"

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"He couldn't. He typed the letter, timing the twitches."

"Jesus."

"As if things weren't bad enough, of course, he happens to be extremely intelligent and sensitive, with the remnants of what was once a terrific sense of humor."

"You've spent time with him?" Callahan asked.

"With great difficulty, about half an hour," Merry said. "The longest I could go without giggling was about ten or twenty seconds, and eventually I gave up, assured him that I had something terrific up my sleeve, and got out of there. My ribs still hurt. There's something about that bark that you just can't get used to. Look, does *anyone* here have any idea what we could do for this poor son of a bitch? He's so damned *lonely* that the tears pour down your face while you're laughing, honest to God."

There was a general rumble of sad negation. "Beats the hell out of me." "Help the poor guy do himself in as painlessly as possible." "Maybe it'll go away . . . in time." "Find a whole lot of blind and deaf guys . . . nah, that's no good." Les and Merry looked more and more downcast.

"I think I got it," Callahan said, and they both looked around sharply, hope beginning to form. "Hey, Drink! Lend me your copper-topper a minute, will you?"

The McGonnigle, puzzled but willing, tossed Mike the night-watchman's cap that he wears even off-duty (because it looks so much like a policeman's hat that he is never ever passed, cut off, or tailgated on the highway). Mike caught it, opened the cash register and took out a fistful of bills, dropped them into the hat.

"Ladies and gentlemen," he boomed, "I'm looking for about three hundred bucks." And he passed the hat to me.

I looked around, saw there were about fifty or sixty of us present, and tossed in a fin. Then I remembered how many of the regulars had lost jobs lately, and added another five, and passed the hat on.

When it got back to Callahan it was overflowing with cash. He totalled it up, and it came to four and a quarter. He beamed around at us all. "Thanks, folks. The cash register just closed for the night." And he began a bucket-brigade of fresh drinks for everyone present.

"Whaddya gonna do wit de cabbage, Boss?" Fast Eddie asked.

"You'll see tomorrow night, Eddie. Or maybe the night after; it might take a while to set up."

"Set up *what?*" Les and Merry chorused.

"Meet me here tomorrow at noon and I'll show you," Callahan promised.

The next evening was Fireside Fill-More Night, on which Fast Eddie and I traditionally jam together. There were four people missing that I had expected to see: the Cheerfuls, Eddie, and Callahan himself. Tom Hauptmann, the second-string bartender, could tell us nothing except that Mike had called him late in the day and asked him to fill in. So I did a solo, and it went well enough . . . but halfway through I got an idea, and invited Doc Webster up to do a bunch of comedy songs—and we brought the house down together.

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I pulled in the next night at about a quarter to eight. Callahan was there in his usual place behind the bar, and Tom Hauptmann was with him. That was a little odd: Mike usually only needs help on weekends, when the crowd is thickest, and there weren't enough customers tonight to justify two barkeeps. The TV (no, not Bill Gerrity; I mean the television) was back on the bartop, but the station it was tuned to didn't seem to be on the air; horizontal stripes chased each other up its face. Callahan saw me come in, sized me up with a glance, and had a shot of Bushmill's and a beer ready by the time I reached him. As usual, it was just what I'd have ordered if he'd given me a chance. "Evening, Jake."

"Hi, Mike. How'd you make out on that Billy Walker thing?"

He drew on his cheroot. "We'll find out together at nine o'clock."

"Okay, be mysterious." I sipped and chased a few times, enjoying the contrast of tastes and textures. "Hey, where's the blackboard? This *is* Riddle Night, isn't it?"

On Riddle Night, one of us makes up riddles and the rest of us try and unscramble them. Each solved riddle costs the Riddlemaster/Riddlemistress a drink; each unsolved riddle is a free drink for him/her. Most often we use the classic "Invisible Idiot" or mangled-translation format. You must have heard the old dodge about the translator who rendered "out of sight, out of mind" literally as "invisible idiot." Like that. For example, "festive, meathooks; finish second" would be correctly deciphered as "gala, hands; place" or "Callahan's Place." Semicolons mark the end of a word, commas separate parts of a single word. They can get quite tricky—it once took me months to translate "coffin; baby boy" as Paul Newman. Ordinarily the Riddlemaster (last week's champ) would have had at least half a dozen riddles already chalked up on a big blackboard by the door for study—but last week's champ was Callahan himself, and he hadn't even trotted out the board yet. "We'll get to them later too," he said, and wandered off to replenish the free lunch.

So I washed down my curiosity with the world's oldest whiskey (they got their charter to distill in 1608) and listened to Fast Eddie stitch his way through a medley of Eubie Blake, Willie the Lion, Pinetop Smith, and Memphis Slim. Eddie had to get special hammers for his piano; the thumbtacks used to keep falling out. I was mildly sorry I'd left my guitar at home; I'd missed my weekly jam with him. The joint filled up while he played, and our spirits danced to his merry tune. When Eddie's on a roll like that, people tend to shut up and dig it. Once a loud newcomer distracted the runty little piano man in the middle of "Tricky Fingers." Eddie got the sap from his boot and pegged it across the room, laid the fellow out, and damned if the sap didn't bounce back right to his hand—and not a note did he fluff during the procedure. They raise 'em tough in Red Hook.

About the time my hands were getting sore from clapping time with him, Eddie went into a classic bar-room walkout and nailed it shut behind him, to thunderous applause. A storm of empty glasses converged on the fireplace and shattered together in tribute, and the two

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bartenders were busy for a time. And then Callahan called for order. I glanced at my watch; it was nearly nine.

"Ladies and gentlemen and regular customers," he announced, "tonight is Riddle Night. By our customs, I am Riddlemaster, on account of I wiped the floor with you mugs last week. But I'm yielding the floor—or at least part of the counter—to a guest Riddlemaster." He reached under the bar, and took out a flat object patchcorded to the back of the television. His microprocessor keyboard. He did something to it, and the stripes stopped chasing each other up the screen.

Okay, I'm slow. "The computer is going to make riddles?" I asked.

"Not exactly."

"What's that thing wired to the back of the terminal?" Long-Drink asked.

"A modem," Callahan said, and just then there were two sounds. My digital watch chirped, and the phone rang.

The big redheaded barkeep picked up the handset and put it down on the modem cradle. At once letters began to appear on the screen.

HI, FOLKS. I'M YOUR RIDDLEMASTER FOR THE NIGHT. MY NAME IS BILLY WALKER.

I could feel a big grin growing on the front of my face. "Mike, you Hibernian ham, you're a genius. Lemme at that keyboard."

He showed me how to use it, and I typed in, HI, BILLY. MY NAME'S JAKE.

IT'S JAKE WITH ME IF IT'S JAKE WITH YOU, came the reply. I noticed that there was a pause about every tenth character, and realized that each pause represented a twitch.

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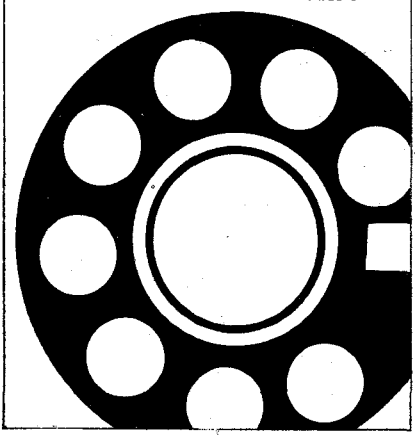

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OKAY, LET'S HAVE SOME RIDDLES. The whole gang was clustered around the monitor now, chattering and laughing; those who hadn't been around the night before last were being filled in.

YOU FOLKS READ SCIENCE FICTION, I UNDERSTAND?

Noah Gonzalez and I always did; as for the rest of the crowd, well, somewhere between the second time-traveler and the third alien we got in Callahan's, most of them picked up on it too. YEAH.

HERE YOU GO, THEN, he replied, and the next lines appeared so rapidly he must have had them stored and ready.

SCOTTISH MT.; FIDDLESTICK, ASSERT

HYDROPHOBIC; Y'KNOW? (CAN.); DRUNK AND MENDACIOUS

ORBS, FEH!; S. AMER. PALM, (COLOR OF ITS FRUIT)

MARVEL COMICS; (QUIET!), GLOVE

WASHROOM; CLONE YOURSELF; ECCENTRIC WHEEL, NONSENSE.

WHAT'S THE TOPIC? I asked him.

YOU TELL ME.

NOW I KNOW WHY THEY CALL IT A CURSOR.

Well, we all took turns chatting with Billy while we worked on his riddles, and it took us several hours to work out that the topic was "SF Writers" and that the answers were, in order,

"Ben; bow, aver" = Ben Bova

"Rabid; eh?; high 'n' lyin' " = Robert A. Heinlein

"Eyes, ech!; asa (mauve)" = Isaac Asimov

"Stan Lee; (shh!), mitt" = Stanley Schmidt

"John; double you; cam, bull" = John W. Campbell, and by that time Doc Webster had come up with the idea of Billy applying for a grant to start up a computer network for shut-ins, and we were all on the way to becoming good friends. Oh, once in a while I'd get a mental picture of the man on the other end of the hookup, and giggle in spite of myself. But he never knew it. I've always hated that hairy old nonsense about high technology being inherently dehumanizing.

And as Doc Webster said, Billy's barks were much worse than his bytes. ■

● What proved fatal to Sparta and Athens, for all their military strength, was their segregation of conquered subjects as aliens. Our founder Romulus, on the other hand, had the wisdom—more than once—to transform whole enemy peoples into Roman citizens within the course of a single day. . . . Senators, however ancient any institution seems, once upon a time it was new!

Claudius Caesar

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The Alternate View

THE DEFENSE OF THE WEST

Jerry Pournelle

It is never easy to write in opposition to Arthur C. Clarke. It is particularly difficult for me, since I owe much to his friendship.

However: I think his guest editorial in the July 1983 *Analog* is seriously mistaken.

Some of his essay is so clearly contradicted by Clarke's other writings and actions that it is impossible to believe that Clarke himself takes the arguments seriously. As an example, he quotes George Bernard Shaw: "In the arts of life, man invents nothing; but in the arts of death, he outdoes Nature herself . . . there is nothing in Man's industrial machinery but his greed and sloth; his heart is in his weapons." This is rather surprising when it comes from the inventor of the communications satellite and co-founder of the British Interplanetary Society.

Clarke himself cannot persuade me that the author of *Fountains of Paradise* is at bottom an anti-technological Luddite. The Shavian quotation ill becomes Clarke; we can only conclude that he feels so strongly about his main issue that he has allowed those feelings to deny him his customary good sense.

Clarke writes in opposition to "the militarisation of space." Many of us think space defenses give new hopes for the survival of freedom. Clarke himself says "we might not be alive today without the stabilising influence of the reconnaissance satellites operated by both the U.S. and the U.S.S.R." It is more than possible that in ten years we will say the same of space-based ballistic missile defenses.

Clarke's essay was based on a speech intended for an international audience. It is customary in such talks to act as if the conflict between the U.S. and U.S.S.R. were symmetrical. Everyone knows better, of course. One might deplore a world dominated by either power, but for nearly all of us, there's little doubt which we'd choose in the disturbing event that there were no other choices.

The Soviet Union has far different aims and goals than does the United States; indeed, one of the major problems of western civilization is that the U.S. doesn't really have any national goals, much less a consistent national strategy; and whatever goals and strategy we may have are not pursued with monolithic unanimity.

They can't be. The U.S. is not organized along military lines. Any national strategy generates domestic opposition. Sometimes that opposition is actually unlawful, yet it continues; and the opponents of our national strategies do not merely survive, but become celebrities.

Things are far different in the Soviet Union.

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If the U.S. has a foreign policy, it is to insure the security of American citizens and their investments abroad. This may not be a particularly noble goal, but at least it implies that Americans can *go* abroad; we haven't found it necessary to employ half a million border guards, not to keep illegal aliens out, but to keep our own citizens in. . . .

Dr. Clarke lives in Sri Lanka, certainly a free nation. How long it would remain free in the absence of a defensible West is another matter. Perhaps forever; but given events in Cuba and Afghanistan this seems unlikely. As for me, I make no secret of it: Western civilization requires defense. I would much prefer a world without weapons of mass destruction, but I don't know how to bring it about.

Indeed, the internal logic of the two major opponents makes real *détente* unlikely. I would certainly be willing to give up the CIA and FBI if the Soviet Union would give up the GRU and KGB, but I don't really think that will happen. If the FBI went out of business, I doubt any States of our Union would secede; on the other hand, the Latvians, Lithuanians, Esthonians, Kerellan Finns, Byelorussians, Ukrainians, Poles, Ruthenians, and some others might feel differently about their Union were it not guarded by large military and police organizations.

I see no help for it. The West requires defenses.

We should, of course, use all means we have available. Clarke proposes an international observation satellite, to be called "PEACESAT." Its data will be available to everyone. The realities of UNESCO, FAO, and other international organizations do not lead me to any great optimism. Still, I cannot fault the concept.

U.S. military people may oppose the PEACESAT system through misguided reflex, but in fact a reliable system for tracking military buildup activities would be an advantage to both sides. Alas, as Clarke says in his essay, the Soviets have rushed to build anti-satellite weapons, even though such a move has "obvious destabilising implications." Once again asymmetries surface: the Soviets can learn much about the U.S. through purchase of maps, government documents, newspapers, and trade journals; because of Soviet secrecy, the U.S. needs satellite information.

In fact, it is an interesting question: why are the Soviets so secretive? Certainly this has been a Russian national characteristic for hundreds of years, but that is not too helpful. Their effective secrecy *is* destabilizing; they know it, and they continue to increase the KGB's power.

Dr. Clarke's PEACESAT is far more likely to be vetoed by the Soviets than by the U.S. Indeed, if it ever comes to pass, you can bet that the U.S. will pay far more than its share. Once PEACESAT is in place, though, the world will still not be safe. There's only so much you can see from orbit.

PEACESAT may be able to give warning not only of impending ground attack, but of ICBM launches. However, the problem is not warning; the problem is what should one do about warning?

It's reasonable to assume that the Soviet Union has no intention of actual

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invasion and occupation of the United States. That task is just too formidable. Does this make us safe?

I would argue that we are not. Perhaps, had the Cold War never happened, both the U.S. and the U.S.S.R. could disarm completely (the phrase used to be UCD—Universal and Complete Disarmament); now, though, it is likely to be several generations before there is sufficient trust. There are compelling ideological reasons for this rather gloomy view.

If either the U.S. or U.S.S.R. thought it could deliver a knockout blow sufficient to neutralize the other side without damage to itself, there would be so many powerful voices raised in favor of pre-emptive war—and so many compelling arguments in favor of "peace through victory"—that thorough disarmament might well be more dangerous than the arms race.

The Soviet Union is, to external appearances, more monolithic in its government than we are. Sometimes we see fissures in the monolith: when we do, we discover that Soviet policymakers are divided not into "hawks and doves," but into hawks and superhawks. The doves don't seem to have reached the upper echelons at all.

In the U.S., a political leader could argue that we shouldn't destroy a helpless U.S.S.R. In the Soviet Union, a similar argument would be treason.

In his essay, Dr. Clarke gives an account of the Cold War in which he argues that the Soviet ICBM program was based almost entirely in reaction to the 1960 campaign and Kennedy's accusation that the Republicans had endangered the nation through allowing the "missile gap" to develop.

Dr. Clarke's account of the Cold War is much too selective. Let's fill in a few details.

In 1938 Hitler and Stalin concluded what has been called a "non-aggression pact." It was much more than that. When Hitler, sheltered by his treaty with the U.S.S.R., took a portion of Poland, the peace of the world was shattered. The Soviet Union marched into Poland at the same time—and indeed took the lion's share of that unfortunate land, as well as all three of the Baltic Republics. The British government actually contemplated war against Russia; and had the Norwegians or Swedes been willing to allow British troops to cross their territory, it's not impossible that a British expeditionary force might have been sent to punish the U.S.S.R.

That's past history.

In 1945 the United States held a nuclear monopoly and commanded the most powerful army and navy in history. With the troops we had in Europe and Asia, plus the atomic bomb, we'd have had little difficulty in conquering a war-exhausted Russia—especially since we would have had the aid of several million Russian exiles and, unlike the Wehrmacht, could truly have come to the Ukraine as liberators.

We did none of that. Instead we dismantled our armed forces while offering to internationalize nuclear weapons. Our offer was refused. Not long after that came the Berlin Crisis, followed by the Korean War—a war which proved that an American president was willing to allow the slaughter of American (and

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British, and Canadian, and Australian) soldiers rather than risk a global war.

That was during the Stalin era. That madman died in 1953. We hoped things would be different when he was gone.

Alas, in 1956 the Hungarians attempted to break free from Soviet domination. The Russians hesitated until they were certain that the U.S. would do nothing; then they crushed the Hungarian freedom fighters. Those old enough will remember: "The Hungarians acted like Poles, the Poles acted like Czechs, and the Czechs acted like swine."

There were also uprisings in East Germany, prompting Berthold Brecht to say, "After the student uprising, the government announced that the people had forfeited its confidence, and must earn it anew. If the government has no confidence in the people, perhaps it ought to dissolve the people, and elect another."

After that came Sputnik, with Russian demonstration of large boosters.

Then, in 1960, John F. Kennedy made the "missile gap" a chief issue of his campaign. The U.S., he said, had fallen far behind.

It's unlikely that Kennedy believed that. Certainly all of us who were involved in the U.S. defense program at that time knew it was hogwash. The CIA threat estimate showed the Soviet missile *potential* as a sharply rising curve; but year after year the curve was shifted to the right, as we found that the Soviets hadn't built many missiles.

They didn't really get started until we did. That much of Clarke's account is true enough. However: after we finished the Minuteman program, we very deliberately and publicly stopped. The last U.S. missile went into its hole in 1966. The theory was that the Soviets would continue to build missiles so long as we did; thus we should halt and allow them to catch up.

They caught up.

They continued to build missiles.

They have halted not, neither have they slowed; and they now have four separate production lines, all running three shifts a day, producing ICBMs. If Dr. Clarke doubts this, let him read the last few annual issues of *The Military Balance*, produced by the London-based Institute for Strategic Studies. Their figures are pretty conservative.

Meanwhile, when the Czechs had had enough of Soviet domination and thought to lessen the burden of Russian-style communism, they learned that Russia is forever. Last year, incidentally, a Prague grocery clerk was sentenced to five years at hard labor for possession of an unregistered mimeograph machine. In Rumania it is a felony to own a typewriter unless you give annual samples of its output to the secret police.

Still, Hungary and Czechoslovakia may be in the "legitimate sphere of influence" of a great power like the U.S.S.R. The "spheres of influence" theory makes pretty hard cheese for a lot of people, but you can't make eggs without breaking omelets. True, Cuba is pretty far from the U.S.S.R. but there's a lot of history behind all that, so maybe we just let things go. . . .

Then came Afghanistan. Meanwhile, Pol Pot in Cambodia proved that the choices are not between red and dead. Cambodian intellectuals got both.

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If one concedes the need for defense of the West, then one must choose a strategy. Secretary McNamara adopted our present policy: Mutual Assured Destruction, or MAD. This doctrine says that the Soviets can't kill us because if they do, we'll kill them back.

Clarke describes this strategy as small boys standing in a pool of gasoline—each trying to acquire more matches than the other. MAD clearly contradicts the Christian doctrine of Just War, since by design it threatens helpless noncombatants while deliberately sparing the enemy's soldiers and war-makers. The logic of MAD leads, eventually, to the very nightmare that haunts Clarke—namely, a policy of launch on warning. We very well could find ourselves in a spot where we had to trust the survival of the human race to a computer—or to surrender.

In 1969 Stefan Possony and I proposed another strategy: Assured Survival. We argued then that a defensive arms race was morally much more acceptable to the West. It would also be inherently stabilizing. Defensive weapons do not kill civilians.

Assured Survival is stabilizing because it deals with a number of horror scenarios. "The Mad General with a Missile (Dr. Strangelove)"; "The Mad Cuban with a Missile"; "Accidental Launch"; "The Demented Scope Dope"; those and a dozen like them, all debated at great length in the strategic analysis community, can be handled by a nation—on either side of the Iron Curtain—which has defensive systems.

Assured Survival and Assured Destruction were debated throughout the '70s. Eventually there emerged a number of scientists, engineers, and strategists who agreed that Assured Survival was both morally right and technologically feasible. One such group formed Project High Frontier.

Arthur Clarke sees Project High Frontier as a "horrifying description of the next phase of space warfare." Since I wrote the preface to that book, it's not surprising that I can't agree. Far from horrifying, I see the possibility of space-based defensive systems as the best hope of the West.

Objections to space-based ballistic missile defenses seem to be grounded on two objections:

1. They won't work, and they'll cost too much.

2. They'll be so effective that they'll give one side strategic dominance, and thus the other side will begin a pre-emptive war before the defenses can be constructed.

Clearly there's a contradiction here.

As to point one: Arthur Clarke, of all people, should know better. Space defense weapons *can* work. Kosta Tsipis can bleat that his opponents "don't understand the laws of physics," but his saying that doesn't make it true.

Costs are another matter. Certainly it won't be cheap. On the other hand, MAD isn't cheap—and if MAD fails, the costs are nearly infinite.

High Frontier, in fact, was originally conceived as a way to *save* money. General Daniel O. Graham, an infantry officer who became director of the Defense Intelligence Agency and deputy director of the CIA, concluded there was no possibility that the U.S. could match the Soviets tank for tank, gun for gun,

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ship for ship; certainly not man for man. We needed, instead, a "strategic end run" which would negate some of their advantages.

Thus was born High Frontier.

There is no easy defense of the West, nor any safe way to the defense of freedom. By all means, let us build Dr. Clarke's PEACESAT. Let us also build shields for our citizens. ■

ON GAMING

(continued from page 81)

The Mansion and London Clue Points work as follows: when you decide whom you want to interview, look at the directory for that case to find the person's reference number for location. You then go to the appropriate clue for that location. Each Clue Point counts as a turn for scoring purposes, but the case description doesn't count against you for scoring.

The point of the game is to solve the crime in the fewest turns. When you think you have the solution, after reading *The Times* and interviewing people associated with the case, compare it with Holmes's in the Case Book.

Note to Readers: Some of the older games mentioned in this column earlier in 1983 are now out of print. For instance, *Barbarian Prince,* a solitaire fantasy game originally published by Heritage USA (now out of business) is no longer available.

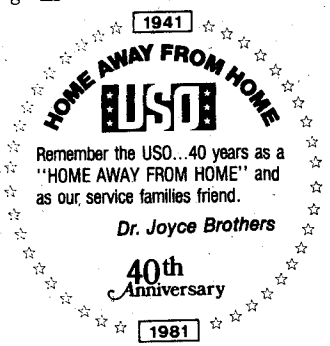
What about other games that may be hard to find? First, check with your local game or hobby stores. If they don't have it in stock, it doesn't necessarily mean the game is out of print. Some older titles can be obtained directly from the publisher by mail. That's why we always provide the manufacturer's address in each review.

If your local stores don't have it, and you can't get an answer from the publisher, try an independent mail-order company. One such firm is American Creative Games Inc., Box 126, Mount Prospect, IL 60056.

If the game really is out of print but you still insist on having a copy, contact the Game Collector's Guild, Box 2162, Washington, DC 20013. You'll pay more for the game (if available) than its original retail price, so you'll have to decide how much a game is worth to you.

If another publisher picks up a good title from a defunct company, you'll read about it here when it becomes available.

Special Request: If you know about a braille version of D & D® *or any other RPG, please contact Mrs. Donna Kay Ring, 269 Terhune Ave., Passaic, NJ 07055. If your group is in the Passaic area and you can use an experienced, blind player, please contact Mrs. Ring.* ■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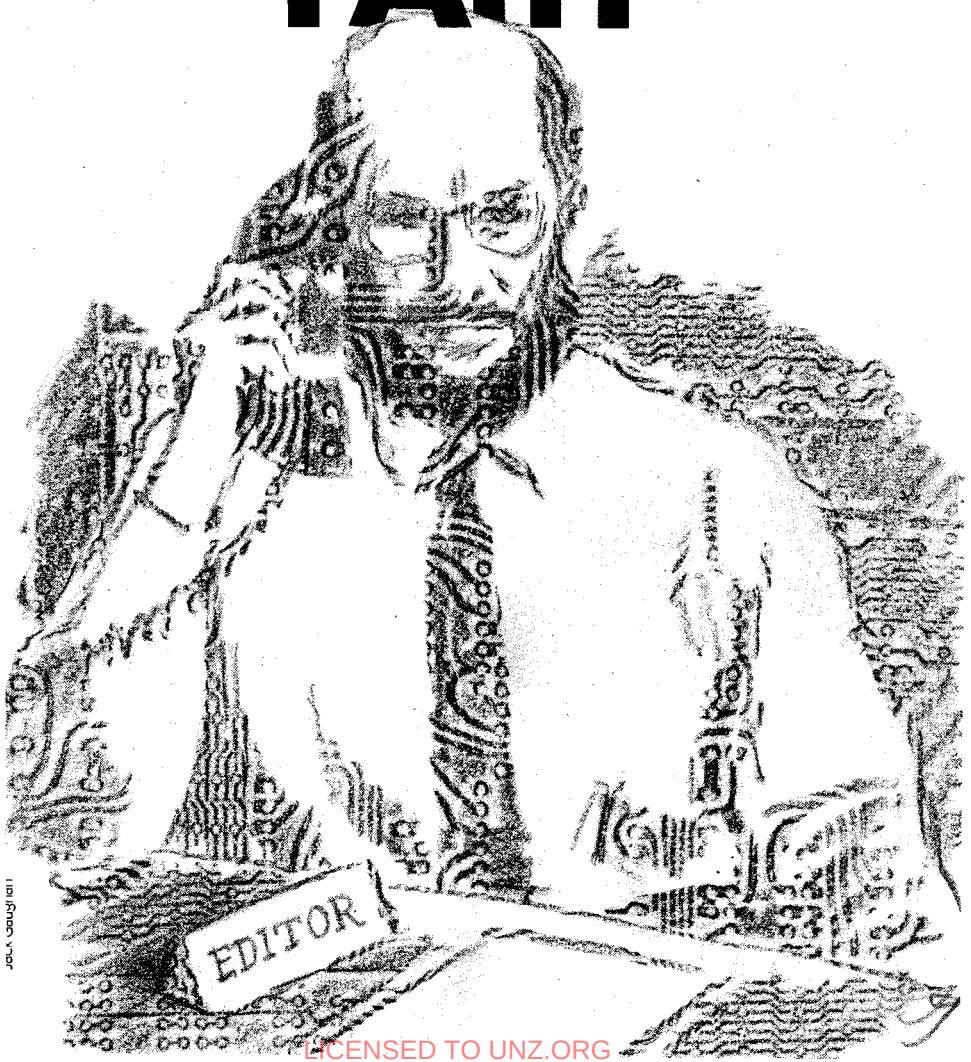
Arlan Keith Andrews, Sr.

CRITICAL PATH



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To join, just send $99.95 to . . .

Dunald Wormely read the brochure carefully. *Sure fits me, all right. I just can't stand for the old lady to see one more fat manila envelope returned to me. I'll give it a try.*

Immense Publications, Inc.
New York, NY 10017
August 25, 1986

Mr. Dunald Wormely
Situs, TN

Dear PubliNet Author:

Thank you for submitting your latest story via PubliNet. May we remind you, however, that you must make your transmissions compatible with our LexiTronix Terminal. Because you failed to do this, your piece arrived garbled.

Please note that we have had to implement a priority queueing system to prevent our terminal from being overworked. Simply stated, it works as follows:

Each writer has a separate file in our memory discs. Each time a writer is successful in selling to us, a number of points proportional to the contract amount is registered. Unsuccessful publication attempts count against this total. The writer's place in the queue is determined by the number of accumulated points at the time the manuscript transmission is attempted.

Your account now reads as follows:

ATTEMPTS	SALES	POINTS	QUEUE POSITION
1	0	−1	−1

Henceforth, please use only electronic mail for correspondence.

Yours,
J. J. Pinkeley,
Reader

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****PUBLINET ELECTRONIC MAIL TO DUNALD WORMELY****

SITUS, TN

18 OCTOBER 1986

THIS ELECTRONIC MAIL MESSAGE VIA PUBLINET IS TO INFORM YOU THAT REGRETFULLY YOUR MANUSCRIPT DOES NOT MEET OUR CURRENT NEEDS. THANK YOU FOR YOUR INTEREST IN IMMENSE PUBLICATIONS, INC.

PUBLINET LEXTRONIX TERMINAL

PUBLINET ADDRESS: SOL-TS-13

YOUR ACCOUNT NOW READS AS FOLLOWS:

ATTEMPTS	SALES	POINTS	QUEUE POSITION
2	0	−2	−8

"Minus eight?" Wormely queried the interactive program. EXPONENTIAL, came back the answer on the CRT.

****PUBLINET ELECTRONIC MAIL TO DUNALD WORMELY****

SITUS, TN

25 DECEMBER 1986

FROM: IMMENSE PUBLICATIONS, INC.

SUBJECT: REQUIREMENTS FOR SUBMISSIONS OF MANUSCRIPTS VIA PUBLINET

IMMENSE PUBLICATIONS, INC., IS HAPPY TO ANNOUNCE THE ACQUISITION OF THE LATEST DATA PROCESSING SOFTWARE AVAILABLE TO THE PUBLISHING INDUSTRY.

CALLED "PARSE" FOR "PUBLICATION ANALYSES RESULTS—STANDARD ENGLISH," THIS NEW PROGRAM EXAMINES INCOMING MANUSCRIPTS BY COMPUTER, ENABLING THE PROSPECTIVE AUTHOR TO HAVE A COMPLETE CRITICAL ANALYSIS OF HIS/HER WORK WITHIN SECONDS OF SUBMISSION. THIS WILL OBVIATE THE NEED FOR THE PREVIOUS QUEUEING PROCEDURE.

WE ARE GLAD TO ANNOUNCE THAT THIS NEW WRITER'S SERVICE IS AVAILABLE AT A SMALL CHARGE THROUGH THE EDITORIAL OFFICES OF IMMENSE PUBLICATIONS, INC. AS AN ADDED CONVENIENCE, YOU MAY PAY FOR THIS SERVICE BY ELECTRONIC FUNDS TRANSFER. MERELY TYPE IN YOUR SOCIAL SECURITY NUMBER AND TERMINAL IDENTIFICATION AND YOUR ACCOUNT WILL BE BILLED.

THANK YOU.

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Wormely sighed and sent in the requested amount for the PARSE service. "Maybe now they'll give me feedback on what's wrong with my stuff." He shook his head.

****PUBLINET ELECTRONIC MAIL TO DUNALD WORMELY****

SITUS, TN

27 DECEMBER 1986

FROM: IMMENSE PUBLICATIONS, INC.

SUBJECT: PARSE ANALYSIS OF MANUSCRIPT

COMMENTS RE YOUR MANUSCRIPT "ICE MAIDENS OF URANUS":

SEXIST LANGUAGE NOT ACCEPTABLE—PAGES—TITLE, 1, 2, 3 . . .

Wormely read on, unbelieving. Of course his story was sexist. It concerned love-starved protein miners among the ice moons of the outer planets. How could they . . . ? But he read on. And on.

SUGGEST REWRITE, USING "PERSONS" TO REPLACE "GIRLS," "GALS," "BROADS". . .

In a mining town? he wondered.

. . . USE OF WORD "WHORES" NOT ACCEPTABLE IN ANY CONTEXT. MUST BE OMITTED.

"But it takes place in a space bordello!" he screamed at the uncaring CRT screen. Without a blink, the videotex message continued.

POLITICAL PERSUASIONS MUST BE LABELED AS SUCH.

What now?

. . . IN VIEW OF FAIRNESS DOCTRINE ADOPTED IN THE 1985 CONGRESS, POTENTIALLY PERSUASIVE POLITICAL ARGUMENTS MUST BE IDENTIFIED.

What arguments? Dunald frowned and tried to think.

. . . POSSIBLE LIBERTARIAN EMOTIONAL INTERPRETATION OF PHRASE: "AH, FREE AT LAST!"—PAGE 1.

. . . ILLEGAL ANARCHIC CONTEXT POSSIBLE IN PHRASE: "DAMN THE REGS! LET'S SAVE OUR BUDDIES!"—PAGE 2.

Wormely couldn't believe his own computer screen. With open mouth, he read on . . .

RACIAL AND ETHNIC REFERENCES NOT PERMITTED UNDER ANY CIRCUMSTANCES.

Now what?

"THE GREEN-SKINNED DEVILS ARE ATTACKING!"—PAGE 4.

"DAMN THE DEEP BLACK PITS OF PRIMAL PLUTO!" SCREAMED THE PERSON.—PAGE 9.

Dunald Wormely sat through the computer's analysis of his 340-page masterpiece. It took seven hours and 1,593 pages of computer scroll. It took enormous patience and restraint.

He went to the bar and fixed a soothing drink—half Scotch and half mixer (a half-gallon of each). After a long time in meditation and a long time drinking, Wormely made his way to his workshop and chose a heavy adjustment tool. Then he returned to his computer once again to try his hand at his last love, writing—a final obeisance

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to the Muse. Deftly and with a determined grin he plyed his keyboard until two entire sentences were in the immense computers at Immense Publications. Then he sat and waited.

****PUBLINET ELECTRONIC MAIL TO DUNALD WORMELY****

FROM: IMMENSE PUBLICATIONS, INC.

SUBJECT: PARSE PROGRAM ANALYSES OF MANUSCRIPT, "IMMORTALS"

Wormely waited. Marking time with the object in his right hand, patting it softly against his left.

MANUSCRIPT HAS ONLY ONE PAGE. SUITABLE ONLY FOR FILLER MARKET.

ANALYSIS OF FIRST FILLER.

FANTASY CONTENT TOO STRONG AND OUT OF CONTEXT. TOO UNREALISTIC.

Dunald grew livid. His patting became a slapping.

POLITICAL UNREST SUGGESTED. REVIEW PREVIOUS MESSAGES CONCERNING POLITICAL PERSUASION.

EVIDENT CONTRADICTION IN LOGIC.

SUMMARY: FILLER NOT ACCEPTABLE. DOES NOT MEET MINIMUM STANDARDS OF PARSE PROGRAM.

END OF ANALYSIS FOR FILLER 1.

BEGIN ANALYSIS OF FILLER 2.

Wormely sat with an idiotic expression distorting his features. He looked at the hard copy of the printout of his submission: "It was the best of times, it was the worst of times."

Simultaneously on the CRT screen and in his mind appeared the next and final one-line sentence:

PUT DOWN THAT WRENCH! *Put down that wrench!*

Smiling insanely, and with great vigor, he did. ■

● The noble science of Geology loses glory from the extreme imperfection of the record. The crust of the earth with its embedded remains must not be looked at as a well-filled museum, but as a poor collection made at hazard and at rare intervals.

Charles Darwin, *Origin of Species,* 1859

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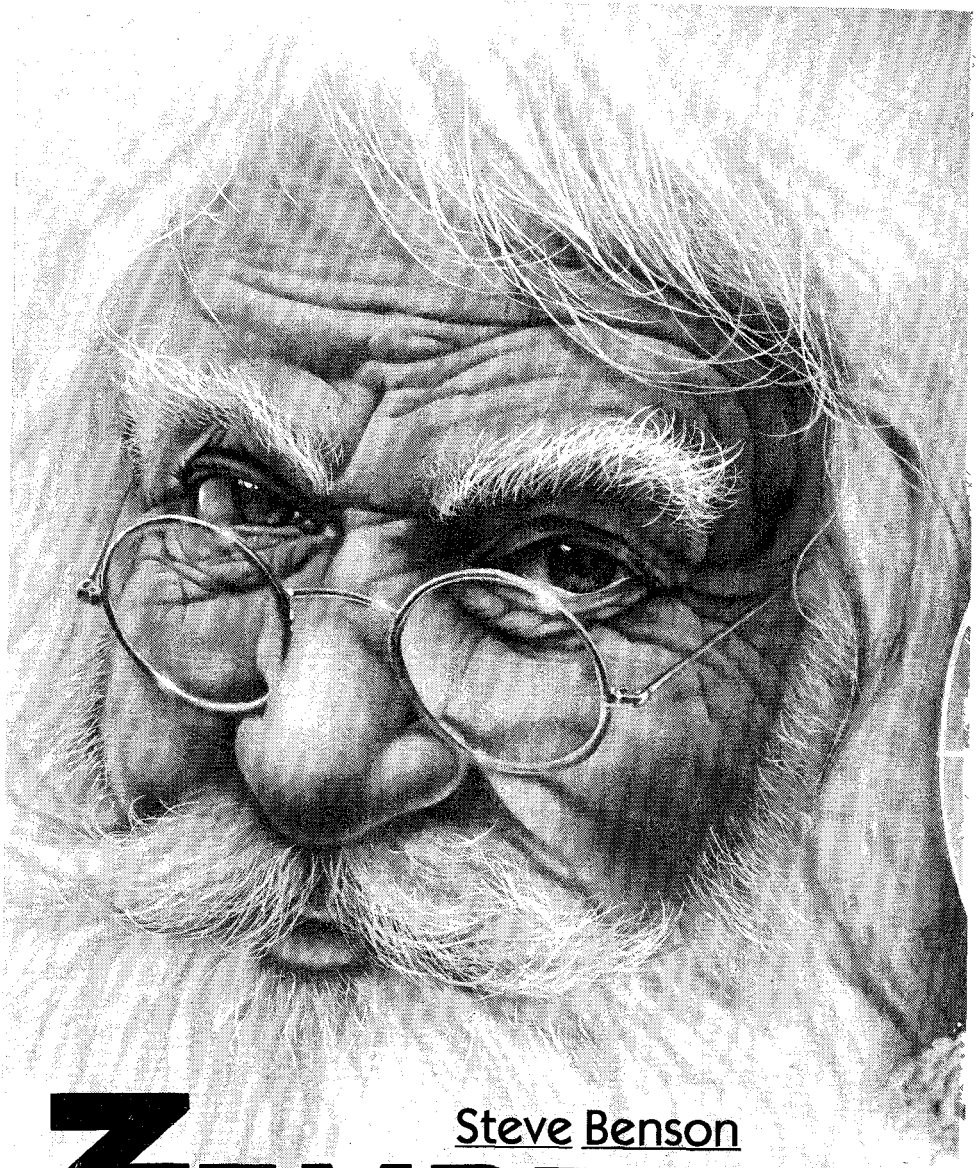

Steve Benson

AN EMPTY GIFT

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Whether a piece of technology is "good" or "bad" depends largely on how it is used—and the original builder is likely to have a very limited view of the possible uses.

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Timothy knelt beneath a steel-gray sky, wearily scooping snow into a bucket with his hands. He wore no gloves. His hands were bright red and they burned with cold. Snowflakes swirled around him playfully, landing on his grimy cheeks and forehead. His skin was egg-shell-white beneath the dirt and his hair was stiff, uncombed. Hunger chewed at his stomach; he had not eaten since the day before. There hadn't been enough for everybody, and since he was their leader it was only fair that he go without. Timothy was twelve years old.

The other children had not noticed that Timothy wasn't eating with them. They were too busy wolfing down the last of the canned vegetables. Timothy forced the image from his mind and stared into the bucket. Satisfied that there would be enough snow water for dinner, he pushed himself shakily to his feet.

Angie stood ten feet away, watching him. Timothy swayed weakly back and forth as the world spun around behind his eyes. The four-year-old seemed not to notice. She took a hesitant step closer and said, "I wanna ast you a question."

Timothy blinked, straining to focus on the little girl in the green-and-blue snowsuit. Her nose was running and her hands were jammed deep in her pockets. Timothy licked his cracked lips and frowned. "Angie?" he asked. "What're you doin' outside?"

"I wanna ast you a question," she repeated, a little annoyed that he hadn't heard her the first time. Timothy glanced down at the bucket beside him in the snow. It looked impossibly heavy. His eyelids kept fluttering shut and he couldn't feel his hands. "Timothy?" Angie whined. His eyes snapped open and he looked at her through watery eyes. "Brenda said tomorrow's Christmas!" Angie said, taking another step closer. "So that makes tonight Christmas Eve, doesn't it?" She looked up at him with big, green eyes; eyes desperate for the right answer. Before he could speak, words were pouring out of her in a flood. "I mean, I know it isn't like it's s'posed to be. Not like before the 'splosions and the bad stuff. But that doesn't change *Christmas,* does it?" In a pleading tone, she added, "I mean, Santa's still comin', isn't he?"

Timothy's throat quivered in rage and frustration, and he wanted to shout, "No, there is no Santa Claus, no Christmas Eve, no presents . . . only pain and slow death, only cold and hunger." He squeezed his eyes shut and dropped to his knees. Tears ran down his cheeks and Angie frowned in confusion.

"Timothy?" she whispered, moving closer.

He opened his eyes and looked at her, pitying her, pitying himself. Between sobs, he managed to say, "Yes, Angie. Santa's coming." Her dirty face broke into a grin and she rushed into his arms.

Her laughter was like wind chimes in his ear as she hugged him. "Is Santa *really* coming?" she asked, stepping away from him. Timothy nodded, not trusting himself to speak again. Then Angie was gone, dashing into the house to share the good news: Timothy had said it was Christmas Eve. Santa Claus was coming.

Timothy dragged the bucket up to the house, his head reeling with every step. He could hear the children chattering in the living room, buzzing with excite-

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ment about Christmas. "It isn't fair," Timothy complained, leaning against the front door. "Just not fair. After everything they've been through. And now to put them through Christmas . . ."

A moment later, Timothy opened the door and went into the living room, dragging his wet feet. He dropped the bucket of snow down to melt and turned toward the group of children huddled around the heating duct. A chorus of voices sprang up, demanding that he verify the coming of Santa Claus. Timothy cut through their chatter: "Allen, Derek, we need wood for the fire. C'mon, before it gets too dark." The two ten-year-olds slowly stood and moved away from the others. Masks of sadness covered their childhood, and both seemed on the verge of tears, but the younger children didn't notice. As the three eldest members of their "family" trudged through the front door, the cheerful knot of ragged children returned to trading tales of Christmases past.

Timothy closed the front door roughly and said, "Guess you both heard . . ."

"They're expectin' Santa Claus," Derek whined, tears finally slipping down his cheeks.

Allen nodded in agreement. "They're talking about waiting up for him," he said. His lower lip quivered and his eyes were moist.

"Well, he's not coming, that's all," Timothy said, clenching his teeth. "He's just not gonna show up." He looked down at his feet, giving the others a moment to stop crying. Both boys continued to sob. "Knock it off," Timothy demanded, turning away from them. "We gotta get some wood." He stomped off through the ankle-deep snow with an energy he didn't really feel. Allen and Derek wiped their eyes on crusty coat sleeves and started after him.

For food and firewood, the children had been cannibalizing the neighborhood. The nearest three houses were hacked up badly. Timothy clomped up onto the porch of the fourth house. The front door was gone and he walked inside, not looking back. They had left two hatchets and a hand saw in the house. Timothy was busy breaking up an end table when the other boys shambled in. "Grab a hatchet," Timothy ordered over his shoulder. He was still angry, and it felt good to slam the dull blade into the table. The other boys started cutting away at the huge grandfather clock in the corner of the dining room. Timothy finished with the table, splintering it into pieces that would fit into their coal furnace.

Timothy was sweating and panting as he turned toward the others. "Keep workin' on that clock," he ordered. "I'm goin' upstairs to look around." He slowly climbed the stairs. The banister was gone and he kept close to the wall. He found what he was looking for at the end of the hall. It was a girl's bedroom, done in soft pink with ivory trim. A canopy bed dominated the small room and Timothy shuddered to think that the little girl would never be coming back. Ever.

Through the dusty lace curtains, Timothy could see that it was snowing harder. Along one wall of the bedroom, a row of dolls sat neatly on a pastel shelf. They stared at him with unblinking glass eyes. He paused for a moment before gathering them up and taking

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them downstairs. "What are we gonna do with *them?*" Derek asked, hands on hips. The grandfather clock was in a dozen pieces and Allen was fussing over a splinter in his finger.

"We're gonna play Santa Claus," Timothy explained. "We'll sneak these dolls back into the house and wait 'til the kids go to sleep. Then we put a doll next to each of 'em . . ."

"What about Andy?" Allen asked, still digging at the splinter. Andy was a blue-eyed blonde, every bit of six years old and a dyed-in-the-wool Santa Clause believer. But a doll just wouldn't do.

"Forgot about him," Timothy admitted. "Wait a minute . . ." He disappeared up the steps again. A moment later, he came back, beaming with pleasure. In his hands was a small green tank with a U.S. Army emblem on each side. The anger, frustration, and weariness he had felt only minutes before were gone. "Andy's gonna love this," he said, smiling.

Allen and Derek scrounged some canned goods from a house four doors down. Hidden among the wood and the cans, the dolls were spirited into the house, past the waiting children, and down into the basement. The children were still chattering wildly about Christmas. Timothy understood their excitement; it bothered him that their simple joy was forever beyond him. Part of him resented their blissful ignorance, but there was little room for resentment as he stoked the furnace with chunks of wood. He carefully placed a row of canned goods on top of the filthy furnace to be heated for dinner.

After the meager meal of green beans and carrot slices, Timothy drew Allen and Derek aside. "I'll go downstairs and keep the fire going strong. You two keep watch on the kids. When they're all asleep, come down and we'll bring up the presents." The two nodded eagerly, caught up in the excitement.

The furnace struggled to beat back the cold that poured into the house with every gust of wind. Timothy threw another hunk of grandfather clock into the flames and basked in the wash of heat. He could hear the children's voices echoing through the heating duct. Tossing in more wood, Timothy smiled to think what delight the simple toys would bring. But then the depression swept back over him. Of course, the children would be happy when they woke up to find the gifts, but that would not solve their problem. Here it was, the end of December, with the worst months of winter still to come. Timothy couldn't see how they were going to make it.

He sat down on a thick sheet of cardboard, watching the flames flickering through the furnace grate. His mind drifted back to when there were electricity, gas, and running water. Hot water. Winter had been for sled riding and snowball fights. Winter had been fun; it hadn't been this terrible, threatening monster that lurked outside the walls. He shook his head sadly, thinking, "We should have been moving south."

But they *had* been moving south, avoiding the larger cities because of the radiation. There had been bodies along the way, horrible, dismembered. Then they came across Andrea Mitchell. And the house. Inside, they found what was left of Andrea's parents. Radiation sick-

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ness. The older boys had buried them in a shallow grave behind the house. When they tried to leave, taking Andrea with them, the seven-year-old went into screaming fits. She refused to leave the house and they couldn't just leave her there. Timothy had been against it, but they stayed, wasting precious time.

Winter came six weeks early, dumping eight inches of heavy snow. It hadn't completely melted when the next storm struck. Now it was impossible to travel; they were stuck. Andrea had died two weeks later.

Timothy was not aware of falling asleep. He had crouched down, resting his head against the stone wall. The fire dancing through the grate hypnotized him and his eyelids fluttered shut. Sleep settled over him like a comfortable blanket of release.

Timothy came awake all at once. Stiff with cold, he pushed himself to his feet. All was dark except for the gentle glow coming from the furnace door. He opened the grate to let more light into the basement. There was no way to tell the time, but the pile of toys was still in place. He crept up the dark stairs, being careful not to make noise. Timothy gently opened the door and stepped into the living room.

A cold chill swept over his legs and he frowned. The living room was dark and empty. Somebody was singing outside. He ran to the front door and there were the children, gathered in front of the house. The door hung wide open, letting all that precious heat escape. . . .

It was snowing outside, practically a blizzard. But the children stood in a circle around a small fire, holding hands and singing jumbled versions of Christmas carols as loud as they could.

Timothy stormed through the door, pulling it shut behind him. The children nodded and waved in his direction, but kept singing. He opened his mouth to scold them, but the harsh words stuck in his throat. He swallowed hard and looked at them. They were dressed in dirty, worn clothing, underfed, half frozen, and hopeless, yet they were singing loud enough to burst. The lyrics didn't always match and they weren't all singing to the same tune, but that merry hodgepodge of Christmas music rolled out like a warm blanket through the snowstorm. Timothy found himself singing along.

The song ended raggedly, and Angie waded through the snow over to Timothy. She wrapped her arms around his waist and looked lovingly up into his face. "We're singin' to bring Santa faster," she explained. "See, Allen and Derek even builded a fire so Santa could see us for sure." Timothy saw the light of hope burning in Angie's eyes. It was something he had never seen in her before, and he saw it now in all of them. Even LuAnne, who sobbed herself to sleep every night, looked happy. Allen and Derek were glowing with the Christmas spirit. Timothy smiled back at them, feeling the warm glow in himself.

Suddenly, the spirit drained out of him. He had remembered why they were so happy: Santa Claus was coming. Except there was no Santa Claus. He felt tired, weak, and helpless. Timothy sat down heavily in the snow, not feeling the cold against his legs and back. The children were singing again, but Tim-

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othy didn't join in. The fire danced and fluttered in the wind. No Santa Claus today, kids, Timothy thought. Sorry, but Santa Claus is hiding in a pile of dolls beside the furnace. That's all there is, kids, and there ain't no more.

Timothy stared at the fire, barely hearing the children's song. But underneath the singing, something else came to him, drifting on the wind. Faintly, out of the north, floated the ringing of sleighbells. He shook his head, denying it: There *was no Santa Claus*. But try as he might, Timothy could not deny that the sound was getting louder. The singing had stopped, too. Each child had trailed off until the only sounds were the bells in the distance and the wind whipping around them.

Timothy stood, brushing the snow from his trousers. "Merry Christmas, Santa," Angie cried. And then they were all shouting it, jumping up and down around the fire. Only Timothy was silent, straining his eyes to see something—anything, off to the north. But the curtain of snow was too thick. In the back of his mind, Timothy insisted that Santa Claus *did not exist*. But on the outside, Timothy was smiling.

Timothy suddenly realized that he was shouting, too. He hadn't believed in Santa Claus in years, but here he was, one of *them* again. All his responsibilities had melted away. He was free to be a child, waiting for Santa. The sleighbells were getting louder.

It was Christmas Eve and Santa was coming.

The Soviet TK-740 personnel carrier had been retooled in the months before the outbreak of war. Originally manned by two drivers and a fire control officer, each TK-740 was refitted with a self-directing computer designed to control the vehicle in high-radiation areas too hot for human drivers.

The weapons systems were also tied into the computer, which was programmed for one purpose: elimination of enemy survivors in hot post-war situations. After the primary and secondary targets in the United States had been obliterated, over three hundred of the TK-740's had been air-dropped along the Canadian border to make a sweep toward the south.

Each TK-740 was equipped with twin machine guns, a short-range mortar, and four missile launchers. The computer identified survivors with an infrared scanner, a video camera, and two bi-directional microphones. Any movement registered with the computer as a survivor; the robot tanks slaughtered animals as well as humans on their relentless sweep south. Once satisfied that an area was free of enemy survivors, the computer directed the TK-740 to move south in search of more targets. Sensors under the vehicle kept it on a firm road surface.

A massive plow at the front of the TK-740 swept snow off the road. The heavy treads rattled against the slippery surface of the highway. Several cleats on the left tread had snapped loose and rattled as the heavy vehicle rumbled along through the blinding snowstorm.

The infrared scanner suddenly picked up a bright dot of heat ahead and to the left. The computer switched the weapons systems to alert status. The target was still too far away for a clear video image.

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* * *

Timothy was delighted. It was a dream come true. The children were dancing around the fire, shouting and laughing. Even the fire seemed to have grown brighter. "He's almost here," Angie cried, tugging at Timothy's coat sleeve. But Timothy paid no attention. He was busy staring into the snowstorm, trying to see Santa Claus.

The TK-740 picked up the light from the fire on its video monitor. Now there were several heat-images on the infrared scanner. The computer switched on the heat-seeking missile launcher. The aiming mechanism began tracking left toward the dot of flame, five hundred feet away. So far all the heat-images were in a cluster. It would be easier to get them all at once. The TK-740 rumbled closer, treads beating against the frozen road.

Allen dashed out onto the snow-covered road, screaming with pleasure. Timothy was only vaguely aware of him. The children still huddled around the fire. Some called out to Santa, others sang. Timothy smiled widely and started across the snowy lawn toward Santa.

Three hundred feet away, the TK-740 picked up two fuzzy images on its video scanner. These life-forms seemed to be moving, but not running. All the better. The computer switched the missile system to standby and activated the machine guns instead. Twin gun barrels jumped in their turrets and began tracking Timothy and Allen.

The hulking form of the machine was visible now, a gray silhouette against the heavy blast of snow. Timothy was closest. He cocked his head, confused. The cleats were jangling loudly now, but this didn't *look* like Santa Claus. Timothy took a step backwards. "Allen," he shouted. *"Get off the road!"*

Allen stopped dancing. "But it's Santa Claus," he complained.

The TK-740 tried to click on its headlamps to pick up a better video image, but the lights had already been smashed out. The computer shifted the transmission into neutral and the huge, gray vehicle drifted to a halt at the edge of the lawn, twenty feet from the house.

"I think you'd better come away from there, Allen," Timothy called, his voice trembling. The children had stopped singing. They looked from Timothy, to Allen, to the heavy machine that had appeared out of the storm.

"Is that Santa?" Angie asked, frowning.

The left machine gun turret hummed as it shifted slightly. Now it pointed directly at Allen. "My God, get away from there," Timothy screamed. Allen turned to face the others. He was crying.

"But where's Santa?" LuAnne shouted. The computer within the TK-740 signaled the machine guns to open fire. The firing mechanisms whirred and clicked, but no bullets exploded from the waiting, black muzzles. All the bullets had been used five days earlier in Rome, New York, to kill the last remaining members of a VFW post.

The computer paused, sensing that the machine guns were not working. An instant later, it tried to fire a mortar shell. Again the loading mechanism

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worked perfectly, but there were no shells left in the magazine. The TK-740's entire supply of mortar shells had been used to wipe out a herd of cattle just outside of Elmira, New York. The mortar's firing pin clicked four times and fell silent.

Timothy watched in horror as Allen slipped and fell in the heavy snow. The gun barrel that had been tracking him had stopped moving. Timothy could hear the machine clicking and rattling, but what did that mean?

The cold began to bother the children. Angie shivered and walked over to where Timothy stood. "What's the matter with Santa?" she asked. "Why don't he come out?"

The heat-seeking missiles had been activated, but they, too, were gone. Left without weapons, the TK-740 idled, unsure of its next move.

"Don't know what's wrong with Santa, Angie," Timothy said, taking a step toward the rumbling tank. "But I guess there's only one way to find out if he's in there or not."

The camera twisted in its mount to watch as Timothy approached the side of the machine. He stared up at it, blinking away the snowflakes that crashed into his eyes. His heart thumped wildly as he put his hand on the icy flank of the machine. He shivered at the cold and lifted himself up, using the machine gun turret as a handhold. Then, hand over hand, he moved up the steep side of the TK-740. The computer watched his progress, but there was no way to stop him now.

Timothy crawled behind the opening for the missile launchers. There he found a round hatch, half hidden by the snow. He tugged at the recessed handle and the hatch slowly creaked open. Timothy peered into the darkness, not sure what to expect. "Hello?" he called. His voice echoed back. His right hand brushed against a utility switch, and the inside of the TK-740 was flooded with light.

Inside was the original personnel compartment, stripped down to the bare metal. The technicians had installed the computer system through this hatch and the access ladder was still in place. Timothy gently eased over the lip of the hatch and went down the ladder, one rung at a time. The children all watched, holding their breath, as Timothy disappeared. Inside, the TK-740 was just a rectangular box fashioned out of armor plating. "Nothing fancy," Timothy said to himself. Then an idea came to him. "But it *is* headed south . . ."

Emerging a moment later, Timothy called to the children, "Everybody go in the house. Gather up clothing, food, anything you can carry."

"Why?" asked Derek, rocking back and forth in the snow.

"Because we're all going to see Santa Claus," Timothy shouted back. There was a moment of confusion as the children charged into the house, but Derek waited behind. He shuffled up next to the TK-740 and slapped his open palm against its metal hide.

"You want us to get inside this thing?" Derek asked.

"We can't last much longer staying here," Timothy explained, quietly. Derek nodded.

As the children began straggling out of the house under piles of filthy clothing, Derek asked Timothy in a low

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voice, "There really isn't any Santa Claus, is there?"

Timothy thought for a moment before answering, "I'm really not sure." He gently patted the smooth edge of the access hatch. To the others he called, "OK, everybody line up next to the Santa Express. Allen and Derek will boost you up and I'll lift you the rest of the way."

Soon, everyone was packed inside the TK-740. The compartment was a tight fit, but the engines behind and below them gave off just enough heat to make it comfortable. "Everyone here?" Timothy asked, looking around.

"All present and accounted for, *sir*," Allen said, giving him a happy salute.

"Is this really the Santa Express?" Angie whispered, tugging at Timothy's sleeve.

Timothy swung the access hatch shut and squeezed down beside Angie. "You bet your boots this is the Santa Express," he said, leaning over to kiss her gently on the forehead.

The infrared scanner was fixed on the flickering heat of the fire in front of the house, but the other sensors detected no movement, no targets. Satisfied that it had completed its job, the computer shifted the TK-740 into gear and swung the massive vehicle back onto the road.

Within minutes, the Santa Express had shifted into cruising gear, heading south. Timothy was able to completely relax for the first time in weeks. Allen had remembered to bring along the toys from the basement. The children were busy examining the presents, but as Timothy leaned back, smiling, he was sure that he had gotten the very best Christmas gift of all.

He got his faith back. ■

SCIENCE FICTION analog SCIENCE FACT

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If you have missed some issues, check off what you'd like and mail with your check or money order. Supplies are limited. Please allow four to six weeks for delivery.

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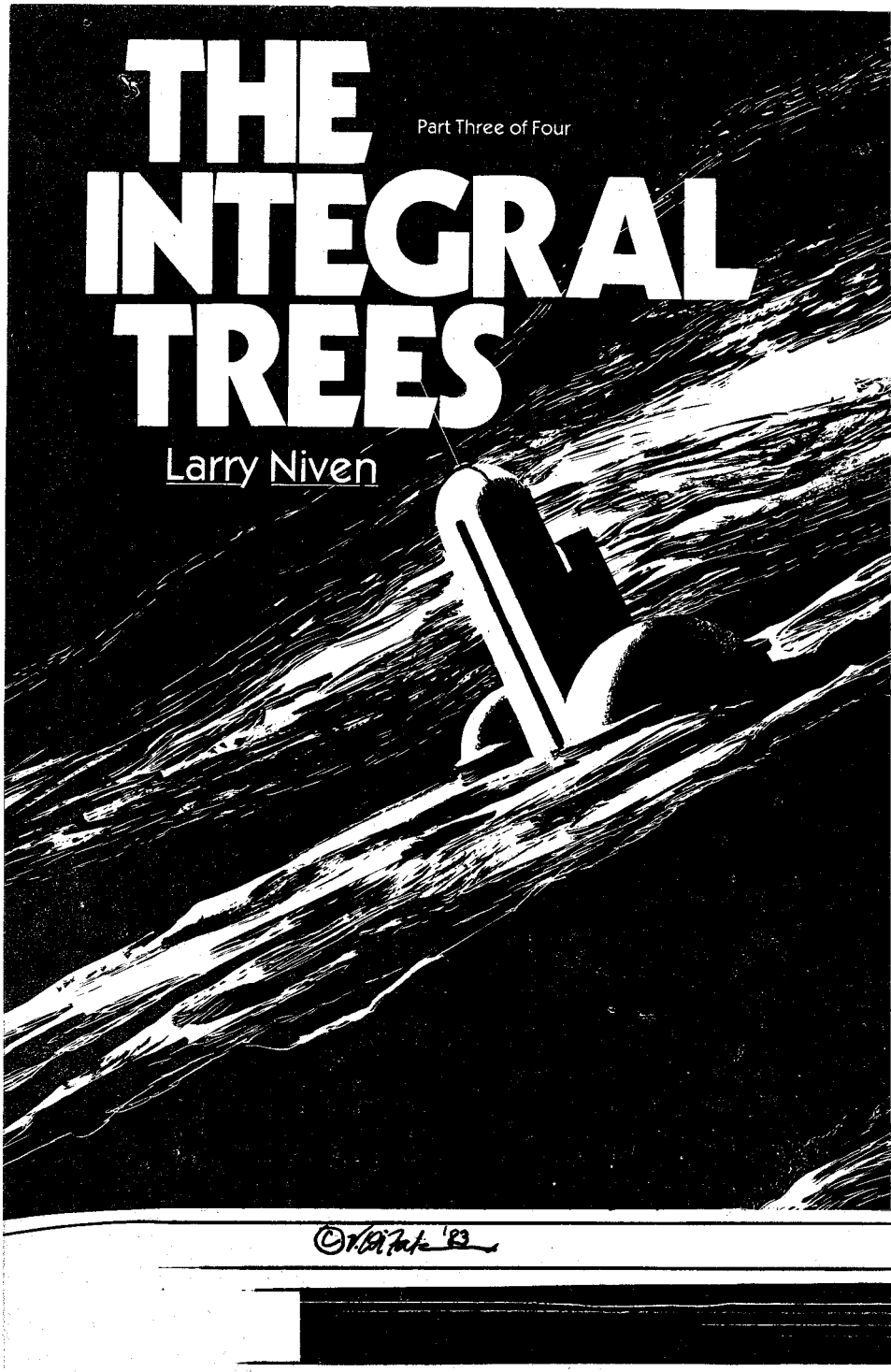
THE INTEGRAL TREES

Part Three of Four

Larry Niven



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SYNOPSIS

Levoy's Star—"Voy"—is the ashes of an ancient supernova, a cold neutron star of half a solar mass.

A gas giant planet circles Voy at four times the Earth's radius. Goldblatt's World—"Gold"—orbits within, and continually leaks its atmosphere into, a gas torus surrounding the neutron star.

The thickest part of the gas torus has the appearance of a green-tinged smoke ring: clouded by water droplets and green with life that has been evolving in free fall for a billion years. The Smoke Ring is illuminated by a G-type companion star, and includes rock and water and soil lost from Goldblatt's World during its first catastrophic approach to Levoy's Star. Its volume—the region where the air becomes thick enough to breathe—is around thirty times that of the Earth.

Five hundred years ago, men entered the ecology.

Integral trees are plants scores of kilometers long and tidally stabilized, radial to Voy. Many of the human tribes have chosen to make their homes in the endpoints, the tufts, where gravity is available.

Dalton-Quinn Tree had a fifth of Earth's gravity at the tufts, and communities at each end. Too close a passage past Gold dropped the tree too far into the gas torus region some years ago. Drought and famine were the result. A hunting party was sent up the trunk from Quinn Tuft, to seek some way of alleviating the famine.

Most of the life forms within the Smoke Ring have some means of staying near the median. To float too far into the near-vacuum of the gas torus region means death. The means by which an integral tree moves has now become obvious to the hunting party.

Dalton-Quinn Tree has ripped apart. Half will fall back into the Smoke Ring, and survive. Half—the half that included Quinn Tuft—will fall further into partial vacuum, and die.

The hunting party had reached the median, and were engaged in battle with citizens of the far tuft, when the tree came apart. **Glory** *has been lost,* **Jiovan** *is dead, and what remains of Quinn Tribe was cast into the sky. Survivors include:*

Gavving, *a young warrior subject to allergies.*

The Grad, *the Scientist's half-trained apprentice. The Grad is carrying Quinn Tribe's cassettes and reader.*

Clave, *a mighty hunter, and the leader.*

Jayan *and* **Jinny**, *twin sisters enamoured of Clave.*

Merril, *an older woman, strong, but barren. Small, withered legs.*

Alfin, *an older man, Keeper of the treemouth. Alfin suffers from what, on Earth, would be mild acrophobia.*

One member has been added: **Minya Dalton-Quinn** *is now married to Gavving.*

The tribe has made heroic efforts to survive. With the unwilling help of a moby, a tremendous bug-skimming beast, they have managed to reach dubious safety in the form of a cotton candy jungle.

The jungle is a flattened puffball several miles in extent. Its foliage resembles that of a stage tree: finely divided to catch maximum sunlight, with little

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regard for structural strength. Inhabitants include gaudy flowers and torpedo-shaped "birds" with a taste for meat.

They've fallen into a war. A huge starstuff relic was sighted attacking defenders on jet pods: a brick-shaped metallic thing with a window at one end and blue fire at the other. Worse, it seems to have sighted Quinn Tribe and is coming toward them. Quinn Tribe has burrowed into the jungle to avoid it.

Clave broke his leg when their raft hit the jungle.

And the Grad has vanished.

CHAPTER 12: THE COPSIK RUNNERS

Birds were raising an incredible ruckus. Unseen hands pulled the Grad headfirst through darkness and the rich smell of alien foliage. Branchlets no longer scratched his face; there must be open space around him.

He'd had no warning at all. Hands had grasped his ankles and pulled him down into another world. His yell was strangled by something stuffed into his mouth, something that wasn't clean; and a rag was tied to hold it in. A blow on the head convinced him not to struggle.

His eyes were beginning to adjust to the gloom.

A tunnel wound through the foliage. It was narrow: big enough for two to crawl side by side, not big enough to walk in. No need, the Grad thought. You couldn't walk with no tide.

His captors were human, roughly speaking.

They were all women, though this needed a second glance. They wore leather vests and trousers, dyed green. The looseness of the vests was their only concession to breasts. Three of the five wore their hair very short, and they all had a gaunt, stretched-out look: two and a half to three meters, taller than any of Quinn Tribe's men.

They held implements: small wooden bows on wooden platforms, the bowstrings pulled back, ready to fire.

They were making good time. The tunnel turned and twisted until the Grad was entirely disoriented. His directional senses wouldn't give him an *up*. It presently opened into a bulb-shape four or five meters across, with three other tunnels leading off. Here the women stopped. One pulled the rag out of his mouth. He spit to the side and said, "Treefodder!"

A woman spoke. Her skin was dark, her hair a compact black storm cloud threaded with white lightning. Her pronunciation was strange, worse than Minya's. "Why did you attack us?"

The Grad shouted in her face. "Stupid! We saw your attackers. They've got a travelling box made of starstuff. That's science! *We* got here on a sheet of bark!"

She nodded as if she'd expected that. "An eccentric way to travel. Who are you? How many are you?"

Should he be hiding that? But Quinn Tribe must find friends somewhere. Go for Gold— "Eight of us. All of Quinn Tribe, now, plus Minya, from the opposite tuft. Our tree came apart and left us marooned."

She frowned. "Tree dwellers? The copsik runners are tree dwellers."

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"Why not? You don't get a tide anywhere else. Who're you?"

She studied him dispassionately. "For a captured invader, you are most impertinent."

"I've got nothing to lose." A moment after he said it, the Grad realized how true it was. Eight survivors had done their best to reach safety, and this was the end of it. Nothing left.

She had spoken. He said, "What?"

"We are Carther States," the black-haired woman repeated impatiently. "I am Kara, the Sharman." She pointed. "Lizeth. Hild." They looked like twins to the Grad's untrained eye: spectrally tall, pale of skin, red hair cropped two centimeters from the skull. "Ilsa." Ilsa's pants were as loose as her vest. That discrete abdominal bulge: Ilsa was pregnant. Her hair was blond fuzz; her scalp showed through. Long hair must be a problem among the branchlets. "Debby." Debby's hair was clean and straight and soft brown, and half a meter long, tied in back. How did she keep it that neat?

Sharman could mean *Shaman*, an old word for *Scientist*. Could mean *Chairman* except that she was a woman . . . but strangers wouldn't do everything the way Quinn Tribe did. And since when did the Chairman take a name?

"You haven't given us your name," Kara said pointedly.

There was something left to him after all. He said it with some pride: "I'm the Quinn Tribe Scientist."

"Name?"

"The Scientist doesn't take one. Once I was called *Jeffer*."

"What are you doing in Carther States?"

"You'd have to ask a moby."

Lizeth snapped her knuckles across the back of his skull, hard enough to sting. He snarled, "I meant it! We were dying of thirst. We hooked a moby. Clave was hoping he'd try to lose us in a pond. He brought us here instead."

The Sharman's face didn't reveal what she thought of that. She said, "Well, it all seems innocent enough. We should discuss your situation after we eat."

The Grad's humiliation kept him silent . . . until he saw their meal, and recognized the harpoon. "That's Alfin's bird."

"It belongs to Carther States," Lizeth informed him.

He found he didn't care. His belly was stridently empty. "That wood looks too green to make a cookfire—"

"Salmon bird is eaten raw, with falling onion when we can get it."

Raw. Yuk. "Falling onion?"

They showed him. Falling onion was a plant parasite that grew at the forks of the branchlets. It grew as a green tube with a spray of pink blossoms at the tip. The pretty brown-haired woman named Debby assembled a handful and cut the blossom-ends off. Ilsa's sword carved the scarlet meat in translucently thin slices.

Meanwhile Kara bound the Grad's right wrist to his ankles, then freed his left. "Don't untie anything else," she warned him.

Raw meat, he thought, and shuddered; but his mouth watered. Hild wrapped sheets of pink meat around the

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stalks and passed one to the Grad. He bit into it.

His mind went blank. You learned to put hunger out of your mind during a famine . . . but he had definitely been hungry. The meat had an odd, rubbery texture. The flavor was rich; the onion-taste was fiery, mouth-filling.

They watched him eat. *I have to talk to them*, he thought hazily. *It's our last chance. We have to join them. Otherwise, what is there? Stay here and be hunted, or let the invaders catch us, or jump into the sky* . . . The man-sized bird was dwindling. Lizeth seemed content to carve slices until they stopped disappearing; Debby was now cutting the falling onions to stretch them. The women had long since finished eating. They watched with irritating smiles. The Grad wondered if they would consider a belch bad manners, and belched anyway, and had to swallow again. He'd learned while climbing the tree: a belch was bad news in free fall, without tide to bring gas to the top of the stomach.

He asked for water. Lizeth gave it to him in a squeezegourd. He drank a good deal. The falling onion had run out. Feeling pleasantly full, the Grad topped off his meal with a handful of foliage.

Nothing could be entirely bad when he felt this good.

Kara the Sharman said, "One thing is clear. You are certainly a refugee. I never saw a starving copsik runner."

A test? The Grad took his time swallowing. "Cute," he said. "Now that that's established, shall we talk?"

"Talk."

"Where are we?"

"Nowhere in particular. I wouldn't lead you to the rest of the tribe until I knew who you were. Even here, the copsik runners might find us."

"Who are they, these . . . runners?"

"Copsik runners. Don't you use the word *copsik*?" It sounded more like *corpsik* when she said it.

He answered, "It's just an insult-word."

"Not to us or them. They take us for corpsiks, to work for them the rest of our lives. *Boy, what are you doing?*"

The Grad had reached for his pack with his free hand. "I am the Quinn Tribe Scientist," he said in freezing tones. "I thought I might find some background on that word."

"Go ahead."

The Grad unwrapped his reader. He had Carther States' undivided attention. The women were awed and wary; Lizeth held her spear at the ready. He chose the records cassette, inserted it into the reader. "Prikazyvat find copsik."

NOT FOUND

"Prikazyvat find," said the Grad, and held the reader to Kara's face. The Sharman shied, then spoke to the machinery. "Corpsik."

CORPSICLE?

The Grad said, "Prikazyvat expound."

The screen filled with print. The Grad asked, "Can you read it?"

"No," Kara said for them all.

" '*Corpsicle* is an insult-term first used to describe people frozen for medical purposes. In the century preceding the founding of the State, some tens of thousands were frozen immediately after death in the hope of someday being revived and cured. This was found to be impossible. The State later made use of

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GLOSSARY

BLUE GHOST and **GHOST CHILD** are aurora-like glow patches produced by magnetic effects above Levoy's Star's poles. Rarely visible.

CARM—Cargo And Repair Module. *Discipline* originally carried ten of these.

COTTON-CANDY JUNGLES or **JUNGLES** describes almost any large cluster of plants. A good many plants and clusters of plants look like fluffy green cotton candy. Many are edible.

COPSIK—Slave. Used as a general insult.

COPSIK-RUNNER—Slavetaker or slavemaster.

DUMBO—A predator of the integral trees.

DAY—One orbit about Levoy's Star, the neutron star. (Equals two hours for Dalton-Quinn tree.)

"FEED THE TREE"—Defecate, or move garbage, or die.

GOLD—See *Goldblatt's World*. Secondary meaning: something to avoid.

GOLDBLATT'S WORLD—A gas giant planet captured after Levoy's Star went supernova/neutron. Named for *Discipline*'s astrophysicist, Sam Goldblatt.

INTEGRAL TREES—A crucial plant.

JET POD—Some plants grow pods that may be carried for attitude control: they jet gasses (of corruption, or of oxygen in plants that favor the outer fringes of the Smoke Ring.)

the stored personalities. Memory patterns could be recorded from a frozen brain, and RNA extracted from the central nervous system. A brainwiped criminal could thus be fitted with a new personality. No citizenship was conferred upon these corpsicles. The treatment was later refined and used by passengers and crew on long interstellar voyages.

" 'The seeder ramship *Discipline*'s crew included eight corpsicles. The memory sets were those of respected citizens of advanced age, with skills appropriate to an interstellar venture. It was hoped that the corpsicles would be grateful to find themselves in healthy, youthful bodies. This assumption proved—' I can't make sense of all that. One thing seems clear enough. A copsik isn't a citizen. He has no rights. He's property."

"That's right," said Debby, to the Sharman's evident annoyance.

So the Sharman doesn't trust me. So? "How do they find you in here? There must be cubic klomters of it, and you know it and they don't. I don't see why you fight at all."

"They find us. Twice now they have found us hidden in the jungle," Kara said bitterly. "Their sharman is better than I am. It may be that their science enhances their senses. Grad, we would be glad to have your knowledge."

"Would you make us citizens?"

The pause lasted only seconds. "If you fight," said Kara.

"Clave broke his leg coming down."

"We make citizens only of those who will fight. Our warriors are fighting now, and who knows if they will repel the corpsik runners? If we can hurt a

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few, perhaps they will not seek out the children and old men and women who host guests."

Guests? Oh, the *pregnant* ones. "What about Clave and the women? What happens to them?"

The Sharman shrugged. "They may live with us, but not as citizens."

Not good, but it might be the best they could get. "I can't say yes or no. We'll have to talk. Kara . . . ah!"

"What is it?"

"I just remembered something. Kara, there are kinds of light you can't see. There used to be machines that could see the warmth of a body. That's how they find you."

The women looked at each other in dread. Debby whispered, "But only a corpse is cold."

"So light little fires all through the forest. Make them check each one."

"Very dangerous. The fire might . . ." she trailed off. "Never mind. Fires go out unless fanned. The smoke smothers them. It might be possible after all, near the jungle surface."

The Grad nodded and reached for more foliage. Things were looking better. If some could become citizens, they could protect the rest. Perhaps Quinn Tribe had found a home. . . .

"Three groups, and they're all going deeper. The traces are getting blurred," said the pilot's blurred voice. The carm hung behind Squad Leader Patry's shoulder, bow aimed at the jungle. "Are you going after them?"

"Groups how big?"

"Three and three and a bigger group. The big group started first. You probably won't catch them."

In the hands of Patry's men a mass of greenery rose from the rest and floated free. Patry reported, "We've found where they dug in. Okay, we're going after them." He joined the waiting men. "Mark, take the point. The rest of you follow me. Go wide of that yellow stuff, it's poison fern."

Mark was a dwarf, the only man in London Tree who could wear the ancient armor, and thus the only possible custodian of the spitgun. Ten years ago he had tended to shy back from an attack, until he gained confidence in his invulnerability. The men had called him Tiny until Patry himself raised hell about it. Mark was born to wear the armor. He'd learned to wear it well.

He climbed past the severed bush and into the dark with London Tree's infantry behind him.

The agony was real, centered above Clave's knee, but spreading in flashes throughout his body. The rest faded in and out. He was being towed through a tunnel. Soon the Scientist's plant extracts would erase the pain. But hadn't the plants died in the drought? And . . . the tree was gone. There wasn't any Scientist, and the Grad had no drugs, and the Grad was gone too. Too few survivors followed the Grad through green gloom. Clave's pitiful remnant of tribe was split, and there was no medicine for an injured man.

Jinny and Minya stopped abruptly, jarring his leg. The pain shouted in his brain. Then they had plunged into the tunnel's branchlet walls, and Clave tumbled in free fall, abandoned.

His tumble turned him and the dream turned nightmare. He faced a bulky,

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LEVOY'S STAR—A neutron star, the heart of the Smoke Ring system. Named for its discoverer, Sharon Levoy, astrogator assigned to *Discipline*.

PRIKAZYVAT—Originally, Russian for "command." Presently used to activate computer programs.

SPINE BRANCHES—Grow from the branch of an integral tree.

SUN—A G0 star orbits the neutron star at 2.5 × 10^8 kilometers, supplying the sunlight that feeds the Smoke Ring's water/oxygen/DNA ecology.

THE CLUMPS—The L4 and L5 points for Gold. They tend to collect debris.

TREEFODDER—Used as a curse. Treefodder is anything that might feed the tree: excrement, or garbage, or a corpse.

VOY—See **LEVOY'S STAR.**

YEAR—Half of a complete circuit of the Sun around Levoy's Star, equal to 1.385 Earth years.

OUT—Away from Levoy's Star.

IN—Toward Levoy's Star.

EAST—In the orbital direction of the gas torus.

WEST—Against the orbital direction of the gas torus. The way the sun moves.

WINDWARD—Into the wind.

LEEWARD—The direction toward which the wind blows.

PORT—To the left if your head is Out and you're facing West, or if your head is In and you're facing East, and so forth. Direction of the Ghost Child.

STARBOARD—Opposite port. Toward the Blue Ghost.

DOWN and **UP**—Usually applied only where tides or thrust operate.

The general rule as known to all Tribes is, "East takes you Out. Out takes you West. West takes you In. In takes you East.

faceless silver thing. The apparition raised something . . . metal? A splinter stabbed into Clave's ribs. He plucked it out. His mind was muzzy . . . was it a thorn? The metal-and-glass creature forced itself through the tunnel wall, ignoring Clave. Acolytes followed it in, blue men carrying huge, unwieldy bows.

The pain had gone and reality was fading. Here was medicine after all.

"I see you've caught up with the first group," the pilot said. "The forward group has stopped. The middle group has joined them. Maybe you should quit."

"I sent Toby back with two copsiks. The third had a broken leg, so we left him. We're almost at full strength. Let's just see what happens."

"Patry, is there something unusual about your mission?"

Classified . . . oh, what did it matter? "Catch some copsiks. Shoot some meatbirds. Collect some spices. Pick up anything scientific." That last wasn't usual. Maybe the First Officer wanted the Scientist to owe him a favor. Patry didn't comment, not with the Scientist's Apprentice listening.

"Fine. You've got copsiks. How many do you need? You don't really expect to find science here, do you?"

"There's a big group ahead. I'm going to at least look at the situation." Patry turned the volume down. Pilots tended to argue a point to death, and Patry wanted silence.

Gavving hadn't burrowed far before Jayan's line led them to a tunnel carved through the foliage. They moved faster then.

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Despite its alien smell, Gavving was hungry enough to try the foliage. The taste was alien too, but it was sweet and went down well. He ate more.

In fact, he felt almost at home here. His toes thrust into branchlets and pushed him down the tunnel in remembered rhythm. Cheeping and croaking rose from thousands of unseen throats. They wouldn't be birds, this deep in the thicket; but they chirped, and if need came they could probably fly. The sound was the sound of Gavving's childhood, before the drought killed the small life throughout the tuft.

It was effort to remember that this wasn't Quinn Tuft; that he followed enemies who knew this thicket as Gavving knew his tree.

Minya, it seemed, didn't have that problem. She was snatching handfuls of foliage, but the hand she used clutched an arrow, and her bow was in the other.

They were moving faster than the line that slithered ahead of them. Merril wound it up as they went. The coil trailed from a thumb; she used both hands to move herself. When Gavving noticed, he said, "Let me do that for awhile. Eat."

"Keep your hands free!" A little later, perhaps regretting her sharpness, she said, "I need my hands to move. You can fight with your hands. Where's your harpoon?"

"On my back. We're all right as long as Jayan is still pulling on the line," he said, and immediately noticed that the line had gone slack. Gavving reached for his harpoon before he moved again.

A disembodied white arm thrust out of the tunnel wall, and beckoned.

Jayan looked out through a screen of branchlets. Her voice was a hoarse and frightened whisper. "They're ahead of us."

"Where?"

"Not far. Don't take the tunnel. There's a long straight part, then it swells out. They'd see you. Go where I go, or they'll hear branchlets breaking."

They followed her into the thicket.

Jayan had broken a trail. Twice she'd had to cut thicker spine branches. In the end they watched from behind a screen of branchlets as the Grad spoke with the weird women.

They were lean and elongated, like exaggerated cartoons of the ideal woman, or like a further stage in human evolution. They looked relaxed. So did the Grad. His feet and one hand were bound, but he was casually eating foliage while they talked. The carcass of a bird was mostly bones.

Minya's breath was warm on his shoulder. She whispered, "It looks like the Grad may have talked them around. I can't hear, can you?"

"No." There was too much birdsong . . . and an occasional crackling as someone moved, making Gavving glad for the birdsong. Still, someone was making too much noise. . . .

Minya leapt through the branchlets in a hideous crackling, straight into the midst of the weird women, screaming, "Monster made of starstuff! There!"

Gavving leapt after her, ready to do battle. He'd have appreciated some warning—

The weird women didn't hesitate an instant. Five of them jumped toward other tunnels and were gone in three directions. The sixth jumped clumsily.

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She struck the edge of the opening and tumbled away unconscious. Had she struck *that* hard?

The Grad was struggling to free his hands. Gavving felt something sting his leg. He turned to fight.

To fight *what?* A thing of glass and metal! There were men behind it— ordinary men who floated free, sighting over their toes as they pulled huge bows taut with their hands—but they didn't fire. The thing of science pointed a metal tube at Minya, then at the Grad. Gavving's harpoon bounced off its mirror-glass face. It pointed at Gavving and stung him again.

You can't fight science, Gavving thought, and he drew his long knife and leapt at the monster. Then everything went dreamy.

"You're too deep," the pilot said. "I can't get individual readings on you. I've got a hot spot, a cluster of a dozen or so. You and the copsiks together?"

"Sounds right. We've got six copsiks here, one already tied up for us. We'll leave the one with no legs. That gives us seven total. A bunch went off through the tunnels. Can you locate them?"

"Yes. It looks like they're together again. There's you, and there's a tighter, brighter spot east of you. I'd say quit now. Kill some meatbirds on the way out."

"There's something here . . . I've got something scientific here, something I don't understand. Too scientific by half." Squad Leader Patry picked up a rectangular mirror that didn't reflect, a mirror that shone by its own light. With some trepidation he flipped an obvious switch. The light went out, to his relief. "You're right, we've got enough. We're coming out."

CHAPTER 13: THE SCIENTIST'S APPRENTICE

Lassitude . . . an odd, pleasant sensation like fizzing in the blood . . . constriction and resistance at his wrists and ankles . . . memories drifting into place, sorting themselves. The Grad waited until his mind was straight before he opened his eyes.

He was bound again, tension at wrists and ankles holding his body straight. *Getting to be a habit.* His bonds gave as he tugged at them. He was tied to netting, face down to a wall that was hard and cold and smooth, and translucent to a millimeter's depth, over a gray substrate.

He'd never seen the like before; but from a distance this stuff might look like metal.

It was the flying box. He was tied to the flying box. He twisted his head left and saw others: Minya, Gavving, Jayan (already awake and trying to hide it), Jinny. To his right, a row of dead salmon birds and ribbon birds, Alfin smiling in his sleep, and one of the Carther Tribe women, the pregnant one, Ilsa. Her eyes were open and empty of hope.

A jovial voice boomed at them. "Some of you are awake by now—" The Grad arched his back to see over his head. The copsik runner was big, burly, cheerful. He clung to the net near the windowed end. "Don't try to wriggle loose. You'll just get lost in the sky,

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and we won't come back for you. We don't want fools for copsiks."

Minya called to him. "May we talk among ourselves?"

"Sure, if you don't interrupt *me*. Now, you're wondering what's going to happen to you. You're going to join London Tree. There's tide when you're in a tree. You'll have to get used to the pull on things, and balancing on your feet without falling, and so forth. You'll get to like it. You can heat water till it boils without it spewing all over the place, and that lets you cook things you never tasted. You always know where you are, by what a thing does if you let go of it. You can drop garbage—" From below their feet came an unnerving whistling roar. The copsik runner's voice rose. "—and know it won't float back at you." He stopped talking because some of his prisoners were screaming.

A tide pulled toward the Grad's feet. He was not surprised to see sky wheeling past: green forest, a strip of blue, billowing white. The textured green below his feet began to contract.

A wet wind blew past. Mist thickened around them. The panicky screams thinned to whimpers, and the Grad heard Alfin's, "Treefodder! We're going back into the treefeeding stormcloud! Whose bright idea—" and he must have silenced himself, because nobody else could have reached him.

Their guard waited for quiet. He said, "It's *very* impolite for a copsik to interrupt a citizen. I am a citizen. I'll forget it for the duration of this voyage, but you will learn. Questions?"

Minya screamed, "What gives you the *right?*"

"Don't ever say that again," the copsik runner said. "Anything else?"

Minya seemed to calm herself in an instant. "What about our children? Will they be copsiks too?"

"They'll have the chance to be citizens. There's an initiation. Some won't want to take it. Some won't pass."

Mist enclosed them completely. The copsik runner himself was half invisible. A wave of droplets each the size of a thumb swept across them, leaving them soaked.

Nobody else seemed inclined to, so the Grad spoke. "Is London Tree stuck in this storm cloud?"

The copsik runner laughed. "We're not stuck anywhere! We moved into the cloud because we need water. After we get you home we'll move out, I expect."

"How?"

"Classified."

Gavving was just waking up. He looked left and right and found the Grad. "What's happening?"

"The good news is we're going to live in a tree."

Gavving tested his bonds while he absorbed that. "As what?"

"Copsiks. Property. Servants."

"Huh. Better than dying of thirst. Where are we? The flying box?"

"Right."

"I don't see Clave. Or Merril."

"Right again."

"I feel wonderful," Gavving said. "Why do I feel so good? Something was on those thorns, maybe, like the red fringe on a fan fungus."

"Could be."

"You're not saying much."

The Grad said, "I don't want to miss

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anything. If I know how we get to London Tree, maybe I could get us back. I had some Carther Tribe citizens convinced that we should join them."

Gavving turned to Minya. They spoke together at length. The Grad didn't try to hear. It was too noisy anyway. The whistling roar had faded, but the windsong was nearly as loud.

"Too many changes," Minya said.

"I know."

"I can't seem to *feel* anything. I want to get angry, but I can't."

"We're drugged."

"It's not that. I was Minya of the Triune Squad of Dalton-Quinn Tuft. Then I was lost in the sky and dying of thirst. I found you and married you and joined the Dark Tuft People. We hitched a ride with a moby and got slung into a jungle. Now we're, what? Copsiks? It's too many changes. Too much."

"All right, I'm a little numb myself. We'll get over it. They can't keep us drugged forever. You're still Minya, the berserker warrior. Just . . . forget it till you need it."

"What will they do with us?"

"I don't know. The Grad's talking escape. I think we'd better wait. We don't know enough."

She found a laugh, somewhere. "At least we don't die virgins."

"We met each other. We were dying, and now we're not dying at all. We're going to a tree, and it can move itself. We'll never see another drought. It could be worse. It's *been* worse. . . . I wish I could see Clave, though."

It was dark and wet around them. Lightning marched a meandering path across the bow. The vehicle swung around. Now the wind blew up from their feet. In that direction a bushy shadow was forming.

"There," said Minya.

The roar of motors resumed.

Gavving watched for a time before he convinced himself that it was one tuft of an integral tree. He'd never seen any tree from such a vantage. They were coming up on the in branch. The tuft was greener and healthier-looking than Quinn Tuft had been, and foliage reached further to cover the branch. The bare wooden tail sported a horizontal platform of hewn wood, clearly a work of tremendous labor.

The roar of science-in-action wavered, rose and fell, as the flying box settled toward the platform. A great arching gap had been chopped through the branch itself, linking this platform to one on the other side. At its west end, where foliage began to sprout, a large hut had been woven.

The whistling roar died.

Then things happened fast. People left the hut on the jump. More appeared from underneath, perhaps from inside the flying box. London Tree's citizens didn't have the incredible height of the forest denizens. Some wore gaudy colors, but most wore tuftberry red, and the men had smooth faces scraped clean of hair. They swarmed to what was now the roof of the flying box and began pulling prisoners loose.

Jinny, Jayan, Minya, and the tall Carther Tribe woman were freed in turn and escorted off the roof of the vehicle. Then nothing happened for a time.

They took the women first. The drug on the needles still held him calm, but that bothered Gavving nonetheless. He

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couldn't see what was happening on the ledge. Presently he was pulled free of the net, lifted, and walked off the roof.

Somehow he had expected normal tides. Here was no more than a third of the tidal force at Quinn Tuft. He drifted down.

Alfin's eyes popped open when the copsik runners turned him loose. They were closing again when he hit the platform. He grunted in protest, then went back to sleep. Two men in tuftberry red picked him up and carried him away.

A copsik runner, a golden-haired woman of twenty or so with a pretty, triangular face, held up the Grad's reader and tapes. "Which of you belongs to these?" she demanded.

The Grad called from above Gavving's head; he was still falling. "They're mine."

"Stay with me," she commanded. "Do you know how to walk? You're short enough to be a tree-dweller."

The Grad staggered when he touched down, but stayed upright. "I can walk."

"Wait with me. We'll use the carm to reach the Citadel."

Strangers were among them, leading Gavving and Alfin toward the big hut. The Grad's eyes followed them, and Gavving would have waved, but his wrists were still tied. A smallish, fussy-looking man in red pushed a bird's carcass into his hampered arms—it was nearly his own mass—and said, "Take this along. Can you cook?"

"No."

"Come." The copsik's hand shoved against the small of his back. He moved in that direction, toward where the fin flowered into tuft. But where were the women?

The flying box had blocked his view. Now he saw the women through the arch, on the other ledge. Minya began struggling, crying, "Wait! That's my husband!"

The drug slowed him down, but Gavving threw the bird into the copsik's arms, sending him tumbling backward under its weight, and tried to jump toward Minya. He never completed the first step. Two men stepped in from either side and caught his arms. They must have been waiting for just such a move. One clouted him across the head hard enough to set the world spinning. They hustled him into the hut.

The copsik was studying Lawri as she studied him. He was thin, with stringy muscles; three or four ce'meters taller than Lawri herself, and not much older. His blond hair and beard were raggedly cut. He was dirty from head to foot. A line of dried blood ran from his right eyebrow to the corner of his jaw. He was very much the kind of copsik who might come spinning from the sky on a sheet of bark, and hardly a convincing man of science.

But his eyes inquired; they judged her. He asked, "Citizen, what will happen to them?"

"Call me Scientist's Apprentice," Lawri said. "Who are you?"

"I'm the Quinn Tribe Scientist," he said.

That made her laugh. "I can hardly call you *Scientist!* Don't you have a name?"

He bristled, but he answered. "I did. Jeffer."

"Jeffer, the other copsiks don't con-

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cern you now. Get aboard the carm and stay out of the pilot's way."

He stood stupidly. "Carm?"

She slapped its metal flank and pronounced the syllables as she had been taught. "Cargo And Repair Module. CARM. In!"

He got through both doors and a few paces beyond, and there he stopped, gaping, trying to see in every direction at once. For the moment she left him to it. She didn't blame him. Few copsiks ever saw the interior of the carm.

Ten chairs faced into a tremendous curved window of thick glass. Images were there that couldn't be outside the glass, nor could they be reflections. They must be in the glass itself: numbers and letters and line drawings in blue and yellow and green.

Behind the chairs was thirty or forty cubic meters of empty space. There were bars set to swivel out of the walls and floor and ceiling, and numerous loops of metal: anchorage for stored goods against the jerky pull of the motors. Even so, the cabin was only a fifth the size of the . . . carm. What was the rest?

When the carm moved, flame had spurted from nostrils at the rear. It seemed that something must burn to move the carm . . . a good deal of it, if it occupied most of the carm's bulk . . . and pumps to move the fuel, and mysteries whose names he'd glimpsed in the cassettes: *attitude jet, life support system, computer, mass sensor, echo laser* . . .

The calm left by the needle had almost left his blood. He was starting to be afraid. Could he learn to read those numbers in the glass? Would he have the chance?

A man in blue lounged before the bow window. A big-boned man of average height, he was still too tall for the chair; what would have been a curved headrest poked him between the shoulder blades. The Scientist's Apprentice spoke briskly. "Please take us to the Citadel."

"I don't have orders to do that."

"Just what are your orders?" Her voice was casual, peremptory.

"I don't have orders yet. The Navy may be interested in these . . . scientific items."

"Confiscate them, if you're sure enough. And I'll tell the Scientist what happened to them, as soon as I'm allowed to contact him. Will you confiscate the copsik too? He says he knows how to work them. Maybe you'd better confiscate me, to talk to him."

The pilot was looking nervous. His glance at the Grad was venomous. A witness to his discomfiture . . . He decided. "Citadel, right." His hands moved.

The girl, forewarned, was clutching the back of the chair. The Grad wasn't. The lurch threw him off balance. He grabbed at something to stop his fall. A handle on the back wall: it twisted in his hand, and dirty water spilled from a nozzle. He turned it off quick, and met the girl's look of disgust.

After perhaps twenty heartbeats the pilot lifted his fingers. The familiar whistling roar—barely audible through the metal walls, but still fearfully strange—went quiet. The Grad immediately made his way to one of the chairs.

The carm was moving away from the

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tuft, east-and-out. Were they leaving London Tree? Why? He didn't ask. He was uncharacteristically leery of playing the fool. He watched the pilot's hands. Symbols and numbers glowed in the bow window and in the panel below it, but the pilot touched only the panel, and only the blue. He could feel the response in shifting sound and shifting tide. *Blue moves the carm?*

"Jeffer. How did you get those wounds?" The blond girl spoke as if she didn't care very much.

Wounds? Oh, his *face*. "The tree came apart," he said. "They do that if they fall too far out of the Smoke Ring. We had a close encounter with Gold some years ago."

That touched her curiosity nerve. "What happens to the people?"

"Quinn Tuft must be dead except for us. Five of us now." He'd accepted that Clave and Merril were gone too.

"You'll have to tell me about it sometime." She tapped what she was carrying. "What are these?"

"Cassettes and a reader. Records."

She thought it over, longer than seemed necessary. Then she reached to plug one of the Grad's cassettes into a slot in front of the pilot. The pilot said, "Hey—"

"Science. My prerogative," she said. She tapped two buttons. (*Buttons*, permanent fixtures in a row of five: yellow, blue, green, white, red. The panel was otherwise blank, save for the transitory glowing lights within. A tap of the yellow button made all the yellow lights disappear; the white button raised new symbols in white.) "Prikazyvat Menu."

The familiar table of contents appeared within the glass: white print flowing upward. She'd chosen the cassette for cosmology. The Grad felt his hands curling to strangle her. *Classified, classified! Mine!*

"Prikazyvat Gold." The print shifted. The pilot was gripped by terrified fascination, unable to look away. The Scientist's Apprentice asked the Grad, "Can you read?"

"Certainly."

"Read."

" 'Goldblatt's World probably originated as a Neptune-like body, a gas giant world in the cometary halo that circles Levoy's Star and Tee-Three, hundreds of billions of kilometers . . . klomters out. A supernova can spew its outer envelope asymmetrically due to its trapped magnetic field, leaving the remaining neutron star with an altered velocity. The planetary orbits go all to hell. In Levoy's s-scenario Goldblatt's World would have dropped very close to Levoy's Star, with its per . . . perihelion actually inside the neutron star's Roche limit. Strong Roche tides would quickly warp the orbit into a circle. The planet would have continued to leak atmosphere to the present day, replacing gasses lost from the Smoke Ring and the gas torus to interstellar space.

" 'Goldblatt estimates that Levoy's Star went supernova a billion years ago. The planet must have been losing atmosphere for all of that time. In its present state Goldblatt's World defies description: a world-sized core of rock and metals—"

"Enough. Very good, you can read. Can you understand what you read?"

"Not that. I can guess that Levoy's Star is Voy and Goldblatt's World is

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Gold. The rest of it—'' The Grad shrugged. His eye caught the pilot's, and the pilot flinched. He seemed shrunken into himself.

Dominance games. The Scientist's Apprentice had assaulted the pilot's mind with the wonders and the cryptic language of science. Now she was saying, ''We have that data on our own cassettes, word for word, as far as I can remember. I hope you brought us something new.''

A shadow was congealing in the silver fog around them. They were drifting back toward London Tree.

The carm's free-falling path had curved back toward the tree's midpoint. *East takes you out. Out takes you west*— He had a great deal to learn about flying the carm. Because he *must* learn. He would learn to fly this thing, or end his days as a copsik.

There were structures here. Huge wooden beams formed a square. Inward, four huts in a column, not of woven foliage, but of cut wood. Cables and tubes ran down the trunk in both directions, further than the Grad could follow. A pond had touched the trunk: a silvery globule clung to the bark, and that seemed strange. A single pond in this region of mist? Men in red moved around it, feeding it water carried in seed pods. It too must be artificial.

With all these artificial structures, London Tree made Quinn Tuft look barbaric! But was it wise to— ''Scientist's Apprentice, do you cut the wood for these structures from the tree itself?''

She answered without looking at him. ''No. We bring it from other integral trees.''

''Good.''

Now she turned, startled and annoyed. He wasn't expected to judge London Tree. The Grad was developing a dislike for the Scientist's Apprentice . . . which he would try to keep in check. If she was behaving as a typical citizen toward a copsik, it augered badly for Quinn Tribe.

The trunk was coming at them, too fast. The Grad was relieved when he heard the motors start and felt the carm slowing. Those wooden beams would just about fit against the carm's windowed end . . . and that was what the pilot was doing, tapping at blue lights, fitting the window into that wooden frame. *Watch his hands!*

CHAPTER 14: TREEMOUTH AND CITADEL

In the large hut the women were stripped naked and examined by two women taller than human, like Ilsa of Carther Tribe. Their long hair was white, and thin enough to expose scalp. The skin seemed to have withered on their bones. Forty to fifty years old, Minya thought, though that was hard to judge; they looked so strange. They wore ponchos in tuftberry-juice scarlet, closed between the legs. Their walk was easy. Minya judged that they had spent many years in the tide of London Tree.

''It looks like people live a long time here,'' she whispered to Jayan, and Jayan nodded.

The supervisors would not answer questions, though they asked many.

They found dirt and wounds in plenty, but no disease. They treated Minya's bruises, and brusquely advised her to

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avoid offending citizens in future. Minya smiled. Offended? She was sure she had broken a man's arm before they clubbed her unconscious.

Ilsa was clearly pregnant. Jayan was also declared pregnant, to her obvious surprise, and sent off with Ilsa. Minya gripped Jinny's arm, afraid that she would attempt a futile battle for her twin.

One of the supervisors noticed Jinny's distress. "They'll be all right," she said. "They carry guests. One of the Scientist's apprentices will have to look them over. Also, the men won't be allowed near them."

The *what* would *what?* But she would say no more, and Minya had to wait.

The Grad watched through the small windows; the big bow window now gave on rugged bark four ce'meters distant. Things were happening outside.

A man in a white tunic was talking to men in blue or red ponchos that fit like oversized sacks. Presently the others all launched themselves along the bark toward the lowest of the column of huts.

"Who's that?" the Grad asked.

The Scientist's Apprentice disdained to answer. The pilot said, "That's Klance the Scientist. Your new owner. No surprise there, he thinks he owns the whole tree."

Klance the Scientist was arguing with himself as he approached the carm. His white smock reached just below his hips; the ends of a citizen's loose poncho showed below. He was tall for a tree-dweller, and lean but for a developing pot belly. Not a fighter, the Grad thought; forty-odd, with slack muscles. His hair was thick and white, his nose narrow and convexly curved. In a moment the Grad heard his voice speaking out of the air.

"Lawri." Sharp, with a peremptory snap in it.

The pilot tapped the yellow button and spread two fingertips apart over the resulting pattern of yellow lines (*remember!*), beating Lawri to it. The carm's two doors swung out and in.

The Scientist was already in conversation as he entered. "They want to know when I can move the tree. Damn fools. They only just finished topping off the reservoir. If I moved it now the water would just float away. First we have to—" He stopped. His eyes flicked to the pilot's back (the pilot hadn't bothered to turn around), then to the Grad, then to Lawri. "Well?"

"He's the Scientist of a ruined tribe. He carried these." Lawri held up plastic boxes.

"Old science." His eyes turned greedy. "Tell me later," he said. "Pilot."

The Navy man's head turned.

"Was the carm damaged in any way? Was anything lost?"

"Certainly not. If you need a detailed report—"

"No, that will do. The rest of the Navy party is waiting for the elevator. I think you can still catch it."

The pilot nodded stiffly. He rose and launched himself toward the twin doors. He nearly brushed the Scientist, who held his ground; pulled himself through the doors, and was gone.

The Scientist tapped at yellow lights. The window sprouted a display. "Fuel tanks are damn near dry. We'll be filling

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them for weeks. Otherwise . . . looks all right. Lawri, from you I do want a detailed report, but tell me now if anything happened."

"He seemed to know what he was doing. I don't love the treefeeder, but he didn't bump any rocks. The foray team brought back these, and him."

The Scientist took the plastic objects Lawri handed him. "A reader!" he breathed. "You bring me treasure. What's your name?"

The Grad hesitated; then, "Jeffer."

"Jeffer, I'll wait for your story. We'll get you cleaned up first. All these years I've been waiting for the Navy to lose my carm, reader and all. I can't tell you what it means to have a spare."

The tide was lighter. Otherwise Minya couldn't tell London Tree from her own tuft. Here was the same green gloom, the same vegetable smells. Branching tunnels ran through foliage stripped bare by passersby. The tall women led them in silence. Jinny and Minya followed. They passed nobody.

They were still naked. Jinny walked hunched over, as if that would cover her. She hadn't spoken since Jayan was taken away.

They had travelled some distance before Minya felt the wind. Minutes later the tunnel swelled out into a great cavity, lit by harsh daylight at the far end.

"Jinny. Was the Commons this big in Quinn Tuft?"

Jinny looked about her, dutifully, and showed no reaction. "No."

"Neither was ours." The cavity ran round the trunk and all the way to the treemouth itself. She could see the empty sky beyond. The shadows were strange, with the blue tinge of Voylight glaring from below. In Dalton-Quinn Tuft Voy had been always overhead.

All that foliage had had to be torn out. Weren't the copsik runners afraid of killing the tree? Or would they only move to another?

Thirty or forty women had formed a line for food. Many were attended by children: three years old and younger. They ignored Minya and Jinny as they were marched past, toward the treemouth.

"Tell me what bothers you most," Minya said.

Jinny didn't answer for several breaths. Then, "Clave."

"He wasn't on the box. He must be still in the jungle. Jinny, his leg has to heal before he can do anything."

"I'll lose him," Jinny said. "He'll come, but I'll lose him. Jayan's got his child. I won't be his any more."

"Clave loves you both," Minya said; though she hadn't the remotest idea how Clave actually thought.

Jinny shook her head. "We belong to the copsik runners, the men. Look, they're already here."

Minya frowned and looked about her. Was Jinny imagining . . . ? Her eye picked up something in the green curve that roofed the Commons, a dark shape hidden in shadow and foliage. She found two more . . . four, five . . . men. She said nothing.

They were led to the edge of the treemouth, almost beneath the great reservoir mounted where branch merged into trunk. Minya looked downslope. Offal, garbage . . . two bodies on platforms, completely covered in cloth. When she

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turned away, their escorts had stepped out of their ponchos.

They took their charges by the arms and led them beneath the huge basin. One of the supervisors heaved on a cord, and water poured forth like a flood in miniature. Minya shuddered with the shock. The women produced lumps of something and one began rubbing it over Minya's body, then handed it to her.

Minya had never experienced soap before. It wasn't frightening, but it was strange. The supervisors soaped themselves too, then let the flood pour forth again. Afterward they dried themselves with their garments, then donned them. They handed scarlet ponchos to Jinny and Minya.

The suds had left her skin feeling strange, tingly. Minya had little trouble stepping into the poncho despite its being sealed between the legs; but it did seem uncomfortably loose. Was it made for the elongated jungle people? It bothered her more that she wore tuftberry-red. Copsik-red here, citizen-red at home. She had worn purple too long.

Their escorts abandoned them at the serving table. Four cooks—more of the elongated women—ladeled a stew of earthlife vegetables and turkey meat into bowls whose rims curved inward. Minya and Jinny settled themselves into a resilient arm of foliage, and ate. The fare was blander than what she was used to in Dalton-Quinn Tuft.

Another copsik settled beside them: two and a half meters tall, middle-aged, walking easily in London Tree's tide. She spoke to Jinny. "You look like you know how to walk. You from a tree?"

Jinny didn't answer. Minya said, "A tree that came apart. I'm Minya Dalton-Quinn. This is Jinny Quinn."

The stranger said, "Heln. No last name, now."

"How long have you been here?"

"Ten years, or something like. I used to be Carther. I keep expecting . . . well."

"Rescue?"

Heln shrugged. "I keep thinking they'll try *something*. Of course they couldn't, then. Anyway, I've got kids now."

"Married?"

Heln looked at her. "They didn't tell you. Okay, they didn't tell me either. The citizens *own* us. Any man who wants you owns you."

"I . . . thought it was something like that." She moved her eyes only, toward the shadows at the outskirts. And they'd watched her naked— "What are they doing, making their selections?"

"That's right." Heln looked up. "Eat faster if you want to finish." Two shadowy men were coming toward them, drifting at leisure along the interlocked branchlets that formed the ground.

Minya watched them while she continued eating. They paused several meters away, waiting. Their ponchos fit more closely than hers, and were a riot of colors. They watched the women, and talked. Minya heard, "—one with the bruises broke Karal's—"

Heln ignored them. Minya tried to do the same. When her bowl was empty, she asked, "What do we do with these?"

"Leave them," Heln said. "If no man takes you, take it back to the cooks. But I think you'll have company. You look like citizens; the men like that."

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She grimaced. "They call us 'jungle giants.' "

Too many changes. Three sleeptimes ago, no man in her local universe would have dared to touch her. What would they do to her if she resisted? What would Gavving think of her? Even if they could escape later—

If she strolled toward the treemouth now, Minya thought, would anyone stop her? She'd be "feeding the tree." A short sprint past the treemouth would put her into the sky before anyone could react. She'd been lost in the sky and survived. . . .

But how could she alert Gavving to jump too? He might not have the chance. He might think it was a mad idea.

It *was* mad. Minya dropped it. And the men strolled over to join them.

The Grad's first meal at the Citadel was simple but strange. He was given a gourd with a fair-sized slot cut in it, and a squeezegourd for liquids, and a two-pronged wooden fork. Thick stew, shipped from the out tuft, had cooled by the time it reached the Citadel. He could recognize two or three of the ingredients. He wanted to ask what he was eating, but it was Klance who asked the questions.

One of the first was, "Were you taught medicine?"

"Certainly." The word was out of his mouth before his mind quite caught up.

Lawri looked dubious. Klance the Scientist laughed. "You're too young to be so sure. Have you worked with children? Injured hunters? Sick women? Women carrying guests?"

"Not with children. Women with guests, yes. Injured hunters, yes. I've treated malnutrition sicknesses. Always with the Scientist supervising." His racing mind told him what to tell Klance. In fact he had worked with children; he had inspected a pregnant woman, once; he had set the bone in Clave's leg. *The old copsik runner won't let me practice on citizens, will he? He'll try me out on copsiks first! My own people . . .*

Klance was saying, "We don't get malnutrition here, thank the Checker. How did you come to be found in a jungle?"

"Inadvertently." Eating strange food with strange implements in free fall took concentration. Not letting it make him sick took a distraction; the Grad was glad for the chance to talk. He ate what he was given, and told the tale of Quinn Tribe's destruction.

The Scientist interrupted with questions about Quinn Tuft, treemouth tending, musrums, flashers, the dumbo, the moby, the insects at the tree median. Lawri seemed fascinated. She burst in only once, demanding to know how one fought swordbirds and triunes. The Grad referred her to Minya and Gavving. Maybe she'd let them know where he was.

The meal ended with a bitter black brew which the Grad refused; and he continued to talk. He was hoarse when he finished.

Klance the Scientist puffed at his pipe—shorter than the one the Quinn Chairman had used—and clouds of smoke drifted sluggishly about the room, and out. The room was more a cage of timber than a hut; there were narrow windows everywhere, and boards would swing to cover them. Klance said,

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"This giant mushroom had hallucinogenic properties, did it?"

"I don't know the word, Klance."

"The red fringe made you feel strange but nice. Maybe that was the reason they were protecting it?"

"I don't think so. There were too many of those fan fungi. This one was big and nicely formed and had a special name."

"The Checker's Hand. Jeffer, have you ever heard that word *Checker* before?"

"My grandmother used to say, 'Tree-feeder must think he's the Checker himself,' when she was mad at the Chairman. I never heard anyone else—"

The Scientist reached for the Grad's reader and one of his own cassettes. "I think I remember . . ."

CHECKER. *Officer entrusted with seeing to it that one or a group of citizens remains loyal to the State. The Checker's responsibility includes the actions, attitudes, and well-being of his charges. The Checker aboard* Discipline *was the recording of Sharls Davis Kendy in the ship's master computer.*

"This is strictly starman stuff. Hmp. The State . . . it took me four days to read the insert on the State. Have you seen it?"

"Yes. Strange people. I did get the feeling that they lived longer than we do."

Klance snorted. "Your Scientist never tumbled to that? They had shorter years. They used one whole circle of their sun for their year. We only use half a circle, but it's still about seven-fifths of a State year. The truth is, we live a little longer than they do, and grow up more slowly, too."

To hear his teacher so slighted set the Grad's ears burning. He barely heard Klance add, "All right, Jeffer, from now on you must think of me as your Checker."

"Yes, Scientist."

"Call me Klance. How do you feel?"

The Grad answered with careful half-truth. "I'm clean, fed, rested, and safe. I'd feel even better if I knew the rest of Quinn Tribe was all right."

"They'll get showers and food and drink and clothing. Their children may become citizens. The same goes for you, Jeffer, whether or not I keep you here; but I think you'd be bored in the tuft."

"So do I, Klance."

"Fine. For the time being I have two Apprentices."

Lawri exploded. "It's unheard of for a freshly claimed copsik to be at the Citadel at all! Won't the Navy—"

"The Navy can feed the tree. The Citadel is mine."

CHAPTER 15: LONDON TREE

Gavving was on the bicycle with three other copsiks.

There wasn't tide enough to pull him against the pedals. Straps ran from the belt around his waist to the bicycle frame. Forcing his legs down against the pedals pushed him up against the belt. After the first session he'd thought he was crippled for life. The endless passage of days had toughened him; his legs no longer hurt, and the muscles were hard to the touch.

The bicycle gears were of old metal.

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They squealed as they moved, and gave forth a scent of old animal grease. The frame was massive, of cut wood. There had been six sets of gears once; Gavving could see where two had been ripped out.

The frame was anchored to the trunk where the tuft grew thin. Foliage grew around the copsiks. Surrounded by sky, with most of the tuft below them, they could still snatch and eat a handful while pedalling. They worked naked, with sweat pooling on their faces and in their armpits.

High up along the trunk, a wooden box descended slowly. A similar box had risen almost out of sight.

Gavving let his legs run on while he watched the elevator descend. The mindless labor let his eyes and ears and mind run free.

There were other structures around the trunk. This level was used for industry, and here were all the men. Man's work and woman's work never seemed to intersect in London Tree, at least not among the copsiks. Sometimes children swarmed through, or watched them with bright, curious eyes. Today there were none.

The citizens of London Tree must have kept copsiks for generations. They were skilled at it. They had chopped Quinn Tribe apart. Even if opportunity came to run, how would he find Minya?

Gavving, pumping steadily, watched storms move sluggishly around a tight knot on the eastern arm of the Smoke Ring. Gold was nearer than he had ever seen it, save for that eerie time when he was a child, when Gold had passed so near and everything had changed.

The jungle hovered hundreds of klomters beyond the out tuft: a harmless-looking green puffball. *How are you doing, Clave? Did that broken leg save your freedom? Merril, were those shrunken legs finally good for something? Or have you become copsiks among the jungle people, or are you dead?*

Over the past eighty-five days or so, twenty sleeps, the tree had drifted to the eastern fringes of the cloud bank. He'd been told, during the trip across the sky to London Tree, that the tree could move by itself. He had seen no evidence of it. Rain swept across them from time to time . . . surely the tree had collected enough water by now. . . .

The elevator had settled into its slot and was releasing passengers. Gavving and the others stopped pedalling. "Navy men," Horse puffed. "Come for the women."

Gavving said, "What?"

"Citizens live in the out tuft. When you see a boxful come down and it's all men, they're come for the women."

Gavving looked away.

"Nine sleeps," said Horse. He was in his fifties, three ce'meters shorter than Gavving, with a bald, freckled head and tremendously strong legs. He had driven the bicycles for two decades. "Forty days till we meet the women. You wouldn't believe how rancy I get thinking about it." By now Gavving was strangling the handbar. Horse saw the muscles standing out along his arms and said, "Boy, I forgot. I was never married, myself. I was born here. Failed the test when I was ten."

Gavving forced himself to speak. "Born here?"

Horse nodded. "My father was a cit-

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izen; at least Mother always said so. Who ever knows?''

''Seems likely. You'd be taller if—''

''Na, na, the jungle giants' kids aren't any taller than the citizens.''

So: children raised in the jungle grew taller, without tide to compress them. ''What are the tests like?''

''We're na supposed to say.''

''Okay.''

The supervisor called, ''Pedal, you copsiks!'' and they did. More passengers were coming down. Over the squeal of the gears Horse said, ''I flunked the obedience test. Sometimes I'm glad I didn't go.''

Huh? ''Go?''

''To another tree. That's where you go if you pass the tests. Heh, you are green, aren't you? Did you think your kids would stay as citizens if they passed the tests?''

''That's . . . yes.'' He hadn't been told that; he'd been allowed to assume it. ''There are other trees? How many? Who lives in them?''

Horse chuckled. ''You want to know everything at once? I think it's four bud trees now, settled by any copsik woman's kid who passes the tests. London Tree goes between them, trading for what they need. Any man's kid has the same chance as a citizen's, because nobody ever knows, see? I thought I wanted to go, once. But it's been thirty-five years.

''I did think I'd be picked for service in the out tuft. I should've been. I'm second generation . . . and when they turned me down for that, I damn near lost my testes for swatting a supervisor. Jorg, there—'' Horse indicated the man pedalling in front of him. ''—he did. Poor copsik. I don't know what the gentled ones do when the Holidays come.''

Gavving still hadn't learned to shave without cutting himself. It was not his choice. All copsiks shaved. He had seen no man wearing a beard in London Tree, save one; and that one was Patry, a Navy officer. ''Horse, is that why they make us shave? So the gentled ones won't be quite so obvious?''

''I never thought of that. Maybe.''

''Horse . . . you must actually have seen the tree move.''

Horse's laughter brought a supervisor's head around. He lowered his voice. ''Did you think it was just a story? We move the tree about once a year! I've been on water details, too, to feed the carm.''

''What's it like?''

''It's like the tide goes slantwise. Going to the treemouth is like climbing a hill. You don't want any hunting parties out when it happens, and you have to tilt the cookpot. The whole trunk of the tree bends a little . . .''

''Lawri,'' said the Grad, ''trouble.''

Lawri glanced back. The pond clung to the bark, a flattened hemisphere. The Grad had run the hose into the water. Now the water was flowing up the outside of the hose, forming a collar.

''Don't worry about it. Just get to the bicycle and pedal,'' Lawri told him. ''And don't call me that.''

The Grad strapped himself to the saddle and started the pedals turning. The gears moved a pump. It was all starstuff, metal, discolored with age. The collar of water shrank as water was sucked into the hose.

It was strange work for the Quinn

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Tuft Scientist, or for the London Tree Scientist's Apprentice, for that matter. Hadn't Klance suggested that he would be better off than the standard run of copsiks? He wondered what Gavving was doing now. Probably worrying about his new and alien wife . . . and with reason.

Water spurted from the hose as Lawri carried it into the carm. The Grad couldn't see what she was doing in there. He pedalled.

In Klance's presence the Grad was Lawri's equal. Otherwise Lawri treated him as a copsik, a spy, or both. He was clean, fed, and clothed. Of the rest of Quinn Tribe he had not even rumors. He and Lawri and the Scientist explored the cassettes together for old knowledge, and that was fascinating enough. But he was learning nothing that would rescue Quinn Tribe.

It was night. Both Voy and the sun were hidden behind the in tuft. In the peculiar light that remained, two faint streamers of blue light fanned out from the tuft. If he stared at them they went away. He could catch them by looking near them. He could almost imagine human shapes pouring as smoke from a squeezegourd. To starboard, the Blue Ghost. To port, even fainter, the Ghost Child.

The Scientist (*the* Scientist) had told him that they were discharges of peculiar energies from the poles of Voy itself. The Scientist had seen them when he was younger, but the Grad had never been able to see them, not even from the midpoint of Dalton-Quinn Tree.

He was sweating. He watched the elevator climb the tree to its housing. A Navy man and two copsiks emerged. None were jungle giants; he had never seen a first-generation copsik at the Citadel, barring himself. They entered the Scientist's laboratory complex, and presently left carrying the dishes from brunch.

Lawri called from the carm. "The tank's full."

The Grad moved with a briskness he didn't feel, unfastening the belt, jerking the hose free of the pond. There were lineholds, wooden hoops, set in the bark to crisscross the citadel region. The Grad used them to make his way toward the carm, calling ahead of him, "Can I help?"

"Just coil the hose," Lawri answered.

She hadn't yet let him into the carm during this operation. The hose must lead, somehow, into a water tank in the carm. They filled it repeatedly, and a couple of days later they would fill it again.

The Grad coiled the hose as he moved toward the carm. He heard cursing from within. Then Lawri called, "I can't move this damn fitting."

The Grad joined her at the doors. "Show me." That easy?

She showed him. The hose attached to a thing on the back wall, with a collar. "It has to be turned. That way." She rotated her hands.

He set his feet, grasped the metal thing, put his back into it. The collar lurched. Again. He turned it until it was loose in his hands, and kept turning. The hose came loose. A mouthful of water spilled out. Lawri nodded and turned away.

"Scientist's Apprentice? Where does the water *go?*"

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"It's taken apart," she said. "The skin of the carm picks up sunlight and pumps the energy into the water. The water comes apart. Oxygen goes in one tank and hydrogen goes in the other. When they come together in the motors, the energy comes back and you get a flame."

He was trying to imagine water coming apart, when Lawri asked, "Why did you want to know?"

"I was a Scientist. Why did you tell me?"

She sent herself skimming across the seats and settled herself at the controls. The Grad moored the coiled hose to fixtures in the cargo area.

The tank must be behind the wall. The carm had been nearly out of fuel . . . which came in two "flavors"? There must be fuel by now; the artificial pond was visibly shrunken.

Lawri tapped the blue button as he came up behind her. The display she'd been studying disappeared before he could see it. The Grad had half forgotten his question when she turned to him and said, "The Scientist quizzes me like that. Since I was ten. If I can't answer I get some dirty job. But I don't like having my buttons pushed, Jeffer, and that information is classified!"

"Scientist's Apprentice, who is it that calls you Lawri?"

"Not you, copsik."

"I know that."

"The Scientist. My parents."

"I don't know anything about marriage customs here."

"Copsiks don't get married."

"You're not a copsik. Would your husband call you Lawri?"

The airlock thumped, and Lawri turned in some relief. "Klance?"

"Yes. Put that display on again, will you, Lawri?"

She looked at the Grad, then back at Klance.

"Now," said the Scientist. Lawri obeyed. She'd made her point: she'd show scientific secrets to a copsik, but only under protest. Dominance games again. If she really cared, she would have removed the hose herself.

The blue lights and numbers had to do with what moved the carm, as green governed the carm's sensing instruments and yellow moved the doors and white read the cassettes . . . and more. He was sure that they all did more than he knew. And red? He'd never seen red.

Every time he saw this display, certain numbers were larger. Now they read: 0_2: 1,664. H_2: 3,181. Klance was nodding in approval. "Ready to go any time. Still, I think we'll feed in the rest of the reservoir. Jeffer, come here." He cut the blue display and activated the yellow. "This number tells you if there's a storm coming, if you watch it."

"What is it?"

"It's the external air pressure."

"Can't you *see* a storm coming?"

"Coming, yes. Forming, no. If the pressure goes up or down fast, over a day or so, there's a storm forming. Lets you impress hell out of the citizens. This is classified, of course."

The Grad asked, "Where does the tree go from here?"

"Out of this rain. Then on to Brighton Tree; they haven't seen us in a while. Grad, you'll get a good chance to look the bud colonies over and pick and choose among them."

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"For what, Klance?"

"For your children, of course."

The Grad laughed. "Klance, how am I going to have children if I spend my life at the Citadel?"

"Don't you know about the Holidays?"

"I never heard of them."

"Well. Every year's-end, when Voy crosses in front of the sun, the copsiks all get together at the treemouth. It's holiday for six days while the copsiks mate and gossip and play games. Even the food comes from the out tuft. The Holidays start in thirty-five days."

"No exceptions? Not even for a Scientist's Apprentice?"

"Don't worry, you'll go," Klance chuckled.

Lawri had turned away, showing her bowed back, the wealth of blond hair floating around her. He wondered then: *How would Lawri have children?* The Scientist didn't seem to be her lover; the Grad knew that he imported copsik women from the in tuft. If she never left the Citadel— How would Lawri ever find a man?

Me?

A copsik could have children, but Lawri could not. It couldn't be helped. He dared not think of Lawri as other than an enemy.

There was flesh against her as she woke. It happened often. Minya shifted position, and refrained from wrapping her arms around the citizen who slept beside her. She might hurt him.

Her motion wakened him. He turned carefully—his arm was bound with cloth against his torso—and said, "Good morning."

"Good morning. How's your arm?" She searched her memory for his name.

"You did a good job on it, but it'll heal."

"I wondered why you came looking for me, given that I broke it."

He scowled. "You stuck in my head. While Lawri was setting the bone I kept seeing your face, two ce'meters away with your teeth bared like you were going for my throat next . . . yeah. So I'm here." The scowl relaxed. "Under, eh, different circumstances."

"Better now?"

"Yes."

His name surfaced. "Karal, I don't remember a Lawri."

"Lawri's not a copsik. She's the Scientist's Apprentice—one of his apprentices, now—and she treats Navy men if we get hurt."

One of his apprentices? Minya gambled. "I hear the new one is a copsik."

"Yes. I saw him from a distance, and he's not a jungle giant. One of yours?"

"Maybe." She stood, donned her poncho. "Will we meet again?"

He hesitated— "Maybe." —and added, "The Holidays are eight sleeps away."

She let her smile show through. *Gavving!* "How long do they last?"

"Six days. And all work stops."

"Well, I have to get to work now."

Karal disappeared into the foliage while Minya strolled into the Commons. She missed Dalton-Quinn Tuft. She'd grown almost used to the obtrusive differences: the huge Commons, the omnipresent supervisors, her own servility. But little things bothered her. She missed cupvines, and copter plants. Nothing grew here but the foliage and the care-

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fully cultivated earthlife, beans and melons and corn and tobacco, as thoroughly regimented as herself.

A dozen copsiks were up and stirring. Minya looked for Jinny and spotted her at the treemouth, just her head showing above the foliage as she fed the tree.

The schedules were loose. If you arrived late, you would work late. Beyond that, the supervisors didn't care much . . . but Minya cared! She would do nothing badly. She would be an exemplary copsik, until the time came to be something else.

She tried to remember nuances of Karal's speech. A citizen's accent was odd, and she had been practicing it.

It had been strange for Minya. Her instincts were at war: a conditioned reflex that resisted sexual assault as blasphemy incarnate, versus the will to live.

Survival won. She would do nothing badly!

Jinny stood up, set her poncho in order, then sprinted west.

Minya screamed. She was too far to do anything but shout and point as she ran. A pair of supervisors, much closer, saw what was happening and ran too.

Jinny plunged through a last screen of foliage, into the sky.

Minya kept running. The supervisors (Haryet and Dloris, hard-faced jungle giants of indeterminate age) had reached the edge. Dloris swung a weighted line round her head, twice and out. Haryet waited her turn, then swung her own line while Dloris pulled. The line resisted as she pulled it in, then gave abruptly. Dloris reeled back, off balance.

Minya reached the edge in time to see the stone at the end of Haryet's line spin round Jinny. Dloris threw her line while Jinny was still fighting Haryet's. Jinny thrashed, then went limp.

Haryet pulled her in.

Jinny huddled on her side, face buried in her arms and knees. By now they were surrounded by copsiks. While Dloris gestured them away, Haryet rolled Jinny on her back, groped for her chin, and pulled her face out of the protection of her arms. Jinny's eyes stayed clenched like fists.

Minya said, "Madam Supervisor, a moment of your attention."

Dloris looked around, surprised at the snap in Minya's voice. "Later," she said.

Jinny began to sob. The sobs shook her like Dalton-Quinn Tree had shaken the day it came apart. Haryet watched for a time, impassively. Then she spread a second poncho over the girl and sat down to watch her.

Dloris turned to Minya. "What is it?"

"If Jinny tries this again and succeeds, would it reflect badly on you?"

"It might. Well?"

"Jinny's twin sister is with the women who carry guests. Jinny has to see her."

"That's forbidden," the jungle giantess said wearily.

When citizens talked like that, Minya had learned to ignore them. "These girls are twins. They've been together all their lives. They should be given some hours to talk."

"I told you, it's forbidden."

"That would be your problem."

Dloris glared in exasperation. "Go join the garbage detail. No, wait. First talk to this Jinny, if she'll talk."

"Yes, Supervisor. And I'd like to be

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checked for pregnancy, at your convenience."

"Later."

Minya bent to speak directly into Jinny's ear. "Jinny, it's Minya. I've talked to Dloris. She'll try to get you together with Jayan."

Jinny was clenched like a knot.

"Jinny. The Grad made it. He's at the Citadel, where the Scientist lives."

Nothing.

"Just hang on, will you? Hang on. Something will happen. Talk to Jayan. See if she's learned anything." Treefodder, there must be something she could say. . . . "Find out where the pregnant women are kept. See if the Grad ever comes down to examine them. He might. Tell him we're hanging on. Waiting."

Jinny didn't move. Her voice was muffled. "All right, I'm listening. But I can't stand it. I can't."

"You're tougher than you think."

"If another man picks me, I'll kill *him*."

Some of them like women who fight, Minya thought. She said instead, "Wait. Wait till we can kill them all."

After a long Jinny uncurled and stood up.

CHAPTER 16: RUMBLINGS OF MUTINY

Gavving woke to a touch on his shoulder. He looked about him without moving.

There were three tiers of hammocks, and Gavving's was in the top layer. The daylit doorway made a black silhouette of a supervisor. He seemed to have fallen asleep standing up: easy enough in London Tree's gentle tide. In the dimness of the barracks, Alfin clung to Gavving's hammock-post. He spoke in a whisper that wanted to shout in jubilation.

"They've put me to work at the treemouth!"

"I thought only women did that," Gavving said, without moving at all. Jorg snored directly below him—a "gentled" man, pudgy and sad, and too stupid to spy on anyone. But the hammocks were close-packed.

"I saw the farm when they took us for showers. There's a lot they're doing wrong. I talked to a supervisor about it. He let me talk to the woman who runs the farm. Kor's her name, and she listens. I'm a consultant."

"Good."

"Give me a couple of hundred days and I might get you in on it too. I want to show what I can do first."

"Did you get a chance to speak to Minya? Or Jinny?"

"Don't even think it. They'd go berserk if we tried to talk to the women."

To be a treemouth tender again . . . seeing Minya, but not allowed to speak to her. Meanwhile, maybe Alfin could carry messages, if he could be talked into taking the risk.

Gavving put it out of his mind. "I learned something today. The tree does move, and it's the carm, the flying box, that moves it. They've settled other trees—"

"What does that do for us?"

"I don't know yet."

Alfin moved away to his hammock.

Patience came hard to Gavving. In the beginning he had thought of nothing

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but escape. At night he could drive himself mad with worry over Minya . . . or he could sleep, and work, and wait, and learn.

The supervisors wouldn't answer questions. What *did* he know, what *had* he learned? The women farmed the treemouth, and cooked; pregnant women lived elsewhere. Men tended machinery and worked with wood, here in the upper reaches of the tuft. The copsiks talked of rescue, but never of revolt.

They wouldn't revolt now anyway, with the Holidays eight sleeps away. Afterward, maybe; but wouldn't the Navy know that from experience? They'd be ready. The supervisors were never without their truncheons, sticks of hardwood half a meter long. Horse said the women supervisors carried them too. During an insurrection the Navy might be given those instead of swords . . . or not.

What else? Bicycle works wore out. Damaging them—damaging anything made of starstuff—would hurt London Tree, but not soon. Here was where the elevators could be sabotaged; but the Navy could still put down a revolt by using the carm.

The carm did everything. It lived at the tree's midpoint, where the Scientist kept his laboratory. Was the Grad there? Was he planning something? He'd seemed determined to escape, even before they reached London Tree.

Was any of that worth anything? *If we were together! We could plan something—*

He had learned that he might spend the rest of his life moving an elevator or pumping water up the trunk. He had not had an allergy attack since his capture. It was not a bad life, and he was dangerously close to becoming used to it. In eight sleeps he would be allowed to see his own wife.

Carther States was setting fires halfway around the biggest flower in the universe.

Clave flapped his blanket at the coals. His arms were plunged elbow-deep in the foliage to anchor him. His toes clutched the edge of the blanket. He undulated his legs and torso to move the blanket in waves, exerting himself just enough to keep the coals red.

Eighty meters away, a huge silver petal gradually shifted position, turning to catch the sun at a sharper angle.

A fire would die in its own smoke, without a breeze, and breezes were rare in the jungle. The day was calm and bright. Clave took it as a chance to exercise his legs.

There was a knot as big as a boy's fist where the break had been on his thighbone. His fingers could feel the hard lump beneath the muscles; his body felt it when he moved. Merril had told him it couldn't be seen. Would she lie to spare him? He was disinclined to ask anyone else.

He was disfigured. But the bone was healing; it hurt less every day. The scar was an impressive pink ridge. He exercised, and waited for war.

There had been tens of days of sleep merging into pain. He'd seen spindly, impossibly tall near-human forms flitting about him at all angles, green shapes fading like ghosts into a dark green background, quiet voices blurred

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in the eternal whisper of the foliage. He had thought he was still dreaming.

But Merril was real. Homely, legless Merril was entirely familiar, entirely real, and mad as hell. The copsik runners had taken everyone. "Everyone but us. They left us. I'll make them sorry for that!"

He had taken little notice, in the pain of a healing bone and the sharper ache of his failure. A hunt leader who had lost his team, a Chairman who had lost his tribe. Quinn Tribe was dead. He told himself that depression always followed a serious wound. He stayed where he was, deep in the dark interior of the jungle, for fear that fluff might grow in the wound; and he slept. He slept a great deal. He didn't have the will to do more.

Merril tried to talk to him. Things weren't that bad. The Grad had impressed the Carthers. Merril and Clave were welcome in the tribe . . . though as copsiks.

Once he woke to find Merril jubilant. "They'll let me fight!" she said, and Clave learned that the Carthers were planning war against London Tree.

Over the following days he grew to know the jungle people. Of around two hundred Carthers, half were copsiks. It didn't seem to carry any onus. Copsiks here lacked for nothing save a voice in the council.

He saw many children and many pregnancies and no starvation. The jungle people were healthy and happy . . . and better armed than Quinn Tribe had been.

He was questioned at a gathering of the tribe. Carther States' Commons was a mere widening in a tunnel, perhaps twelve meters across and twice that long. Surprisingly, the space held everyone. Men and women and children, copsiks and citizens, all clung to the cylinder wall, covering it with an inner layer of heads, while Comlink or the Sharman spoke from one end.

"How can you even *reach* London Tree?" he had asked, but only once. That information was "classified"; spies would not be tolerated. But he could watch the preparations. He was sure these fires were part of it.

He had been flapping wind at the coals for half a day now. His leg was holding up. Soon he would have to shift position.

Kara the Sharman came skimming toward him. She dipped her grapnel into the foliage and stopped herself next to Clave. "How are you doing?"

"You tell me. Does the fire look right?"

She looked. "Keep it that way. Feed it another branch a few hundred breaths from now. How's the leg?"

"Fine. Can we talk?"

"I've other fires to check."

The Sharman was Carther States' equivalent to the Scientist. Maybe the word had meant *Chairman* once. She seemed to have more power than the political boss, the Comlink, who spent most of his time finding out what everybody else wanted. Getting her attention was worth a try. Clave said, "Sharman, I'm a tree dweller. We're going to attack a tree. Shouldn't you be using what I know?"

She considered that. "What can you tell me?"

"Tides. You're not used to tides. I am, and so are these copsik runners. If you—"

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Her smile was twisted. "Put you in charge of our own warriors?"

"Not what I meant. Attack the *middle* of the tree. Make them come to us there. I saw them fighting in free fall, and you're better."

"We thought of that—" She saw his grimace. "No, don't stop. I'm glad you agree. We've watched London Tree for decades now, and two of us did escape once. We know that the copsiks live in the inner tuft, but the carrier is kept at the center of the tree. Should we go after that first?"

Science at the level of the carrier, the flying box, made Clave uneasy. He tried to set the feeling aside. . . . "I saw how they use that thing. They put their own warriors where they want them and leave yours floundering in air. Yes. Get the carrier first, even if you can't fly it."

"All right."

"Sharman, I don't know how you plan to attack. If you'll tell me more, I can give you better answers." He'd said it before. It was like talking to the tree.

Kara freed her grapnel with a snap of the snag line. She was moving on. *Treefodder!* Clave added, "One thing. If I know the Grad, he knows how to fly the carrier by now, if he's had any kind of a chance at it. Or Gavving might have seen something and told the Grad."

"There's no way we'll learn that."

Clave shrugged.

"We'll go for the carrier and try for the Grad."

Clave pushed a dead spine branch into the coals and resumed flapping his blanket.

Kara said, "You call yourself Sharman . . . *Chairman* of a destroyed people. I trust you know how to be a leader. If you learn things that should not be known to our enemies . . . if you ride to war in the first gust of warriors . . . what would you tell my citizens, if you were me?"

That was clear enough. " 'Clave must not live to be captured and questioned.' Sharman, I have little to lose. If I can't rescue my people, I'll kill copsik runners!"

"Merril?"

"She'll fight with me. Not under tides, though. And . . . don't tell her anything. *I* won't kill Merril if she's captured."

"Fair enough. You called the funnel a 'treemouth'—"

"I was wrong, wasn't I? The jungle can't feed itself that way. There's not enough wind. What is it?"

"It's what makes the jungle move. The petals are part of it too. Whatever side of the jungle is most dry, there the funnel wants to face. The petals reflect sunlight to swing the jungle round in that direction."

"You talk like the jungle is a whole creature, that thinks."

She smiled. "It's not very smart. We're fooling it now. The fires are to make the jungle dry on one side."

"Oh."

"There are tens of life forms in the jungle. One of them is a kind of . . . spine for the whole thing. Its life is deep down, and it lives off the dead stuff that drifts toward the center. Everything in the jungle contributes something. The foliage is various plants that root in what the jungle-heart collects, but they rot and feed the jungle-

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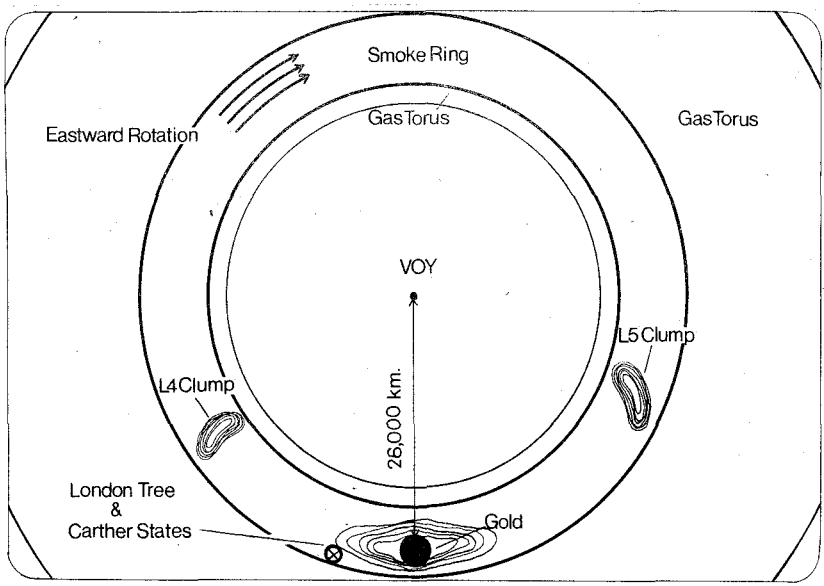

heart, and shield the jungle-heart if something big hits the jungle. We do our part too. We transport fertilizer down—dead leaves and garbage and our own dead—and we kill burrowing parasites."

"How does a jungle move? The Grad didn't know."

"The silver petals turn the jungle to put the funnel where the jungle is most dry. If everything gets too dry, then the funnel spits hot steam."

"So?"

"Clave, it's time to put the fires out. I must tell the others. I'll be back."

Minya followed Dloris through twisting, branching tunnels. Minya's grip on Jinny's arm was relaxed; it would tighten if Jinny tried anything foolish. But the treemouth, and any chance to leap into the sky, were farther away with every step.

The way the tunnels twisted, Minya wasn't sure where she was. Near the midbranch, she thought; and the tuft would be narrowing toward the fin. She couldn't see solid wood, but from the way the spine branches pointed, the branch was below and to her left. Earlier she had passed a branching tunnel and heard children's laughter and the shouting of frustrated adults: the schools. She could find this place again.

The mouth of a woven hut showed ahead. Dloris stopped. "Minya. If anyone asks . . . you and Jinny both think you're pregnant. So the Scientist's Apprentice will examine you both. Jinny, I'll take you to your sister, and what happens then is none of *my* business."

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They had reached the hut. Dloris shooed them in. Two men waited inside, one in Navy blue, the other— "Who are you?" Dloris demanded.

"Madam Supervisor? I'm Jeffer, the Scientist's Apprentice . . . other apprentice. Lawri is otherwise engaged."

To meet both Minya and Jinny was more than the Grad had hoped for.

He introduced his Navy escort to the women; Ordon was clearly interested. Ordon and Dloris stayed while the Grad questioned Jinny. She couldn't be pregnant, the timing was wrong, and he told her so. She and Dloris nodded as if they'd expected that, and departed the hut through the back.

He asked Minya the appropriate questions. She hadn't menstruated since a dozen sleeps before Dalton-Quinn Tree came apart. He told the Navy man, "I'm going to have to examine her."

Ordon took the hint. "I'll be right outside."

The Grad explained what was needed. Minya stepped out of her poncho's lower loop, lifted it and lay down on the table. The Grad palped her abdomen and her breasts. He tested the secretions of her vagina in plant juices Klance had shown him how to use. He'd practiced such an examination in Quinn Tuft, with the Scientist supervising, as part of his training. Once.

"No problem. A normal pregnancy," he said. "It's anyone's guess when it happened."

Minya sighed. "All right. Dloris said so too. At least it gives me a chance to see you. Could it be Gavving's?"

"The timing's right, but . . . you've been available to the citizens, haven't you?"

"Yes."

"Minya, shall I tell Gavving it's his?"

"Let me think." Minya ran faces past her memory. Some were blurs, and she liked it that way. Did they resemble Gavving at all? But the arrogant dwarf had claimed two of her sleeptimes— "No. What's the truth? You don't know?"

"That's right."

"Tell him that. We'll just have to see what the child looks like."

"All right."

Jinny and Dloris had gone down to the pregnant women's complex, a good, safe distance away. Luckily the Grad's guard was male. A woman might not have given them privacy during the examination. With her poncho hiked up and her legs apart, Minya said, "Stay where you are in case Ordon peeks in. Grad, is there any chance of getting us out of here?"

Keeping his head clear wasn't easy under the circumstances, but he made the effort. "Don't move without me. I mean it. We can't do *anything* unless we can stop them using the carm."

"I wasn't sure you were still with us."

"With you?" He was startled . . . though he had had doubts. There was so much to *learn* here! But what was it like for the others, for Gavving or Minya? "Of course I want to break us free! But no matter what we do, they can stop us while they've got the carm. And have you seen a dwarf around?" *Like Harp*, he thought, but Minya hadn't known Harp.

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"I know him. Mark. Acts like he's three meters tall, but he's less than two. Thick-bodied, lots of muscles, likes to show them off." Bruises healing on her arms helped her to remember.

"He's important. He's the only one who can use the old armor."

"We'd like him to meet with an accident?"

"If it's convenient. Don't do anything till we're ready to move."

She laughed suddenly. "I admire your coolness."

"Really? Look down."

She looked, and blushed and covered her mouth. "How long—?"

"Ever since you pulled up your poncho. I'm going to have a serious case of lover's plaint."

"When I first met you I thought . . . no, don't move. Remember the guard."

He nodded and stayed where he was. She said, "Grad . . . my guest . . . I hope it's Gavving's, but it's already there, no matter whose. Let's—" She sought words, but the Grad was already moving. She finished in a breathless laugh. "—solve your problem."

The poncho was ludicrously convenient. It need only be pulled aside. He had to bite hard on his tongue to hold his silence. It was over in a few tens of breaths; it took longer to find his voice. "Thank you. Thank you, Minya. It's been . . . she's . . . I was afraid I'd be giving up women."

"Don't do that." Minya's voice was husky. She laughed suddenly. *"She?"*

"The other apprentice is a citizen who treats me like a thieving copsik. Either I'm dirt for the treemouth or I'm a spy. Anyway, it's my problem. Thanks."

"It wasn't a gift, Grad." She reached down to squeeze his hands. "I'm sick of being treated like a copsik too. When do we get *loose?"*

"Quick. It has to be. The First Officer has spoken. We move the tree as soon as possible."

"When's that?"

"Days, maybe less. I'll know when I get back to the Citadel. Lawri's up there counting-down the carm's motor systems. I'd give either testicle to be in two places at once, but I *couldn't* miss the chance to talk to you. Can you pass a message to Gavving?"

"No way at all."

"Okay. There's a cluster of huts under the branch, and that's where the women stay when they carry guests, for more tidal pull while the baby's developing. So. Is there anyone at the treemouth that you want fighting beside you?"

"Maybe." She thought of Heln.

"Maybe isn't good enough. Skip the treemouth. If something happens, grab Jayan and anyone else you think you need and go up. A lot of the men spend their time at the top of the treemouth. We can hope Gavving and Alfin are there. But wait till something drastic happens."

CHAPTER 17: "WHEN BIRNHAM WOOD—"

The huge silver petals were rising, folding inward. The funnel at their center faced east-and-out, and the sun was moving into line with the funnel. Gold

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was eastward, and seemed close. The sluggish whorl of storm was a strange sight, neither mundane nor scientific, but mind-gripping.

Clave and Kara were alone. The other fire-tenders had gone elsewhere after the fires were quenched. The Sharman asked, "Do you know the law of reaction?"

"I'm not a baby."

"When the steam spits from the funnel, the jungle moves in the opposite direction. That would be back to moister surroundings, back into the Smoke Ring, if we weren't . . . meddling. Afterward something must be regrown: fuel, perhaps. It takes twenty years."

"That's why they've been getting away with the raids."

"Yes. But no more."

The petals stood at thirty degrees from vertical. The sun shone directly into the funnel, and the petals were shining into it too. The funnel cupped an intolerable glare.

Kara said, "The jungle-heart spits when the sun shines straight into the blossom. It's not easy to make it spit at a chosen time, but . . . this day, I think."

It came as if by the Sharman's command: a soft, bone-shaking *fumf* from the funnel. Clave felt heat on his face. The jungle shuddered. Kara and Clave clung tight with hands and feet.

A cloud began to form between himself and the sun. A column of steam, racing away from him. He felt a tug, a tide, pulling him toward the sky.

"It works," he said. "I didn't . . . How long till we reach the tree?"

"A day, maybe less. The warriors are gathering now."

"*What?* Why didn't you tell me?" Without waiting for an answer, Clave dove into the foliage. His thoughts were murderous. Had she cost him his place in the coming battle? *Why?*

Four copsiks were running the elevator lines with their legs, and the Grad's eye caught Gavving among them. The elevator had almost reached its cradle. Was there no way to tell him? *Minya's with the pregnant women. She's fine. I'm in the Citadel—*

Ordon said, "So you couldn't wait for the Holidays."

The Grad jumped violently. For a moment he was actually floating. Ordon bellowed laughter. "Hey, forget it, it's nothing. With a chance like that, how could you not? That's why Dloris got a little upset when she saw you weren't Lawri."

The Grad grinned a sickly grin. "Did you watch the whole time?"

"No, I don't need to get my kicks that way. I can visit the Commons. I just poked my head in and saw what you were poking and pulled it back out again." He put the Grad into the elevator with a friendly, forceful shove in the small of his back and followed him in.

He seemed friendly enough, but first and last he was the Grad's guard. The Grad was not to be harmed; the Grad was not to escape. He liked to talk, but . . . They had come to the pregnant women's complex the long way round, by way of the Navy installation on the fin. They had returned by the same route. Presumably Ordon had some business on the fin. The Grad had asked about it. Ordon had become coldly sus-

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picious. He would not talk to a copsik about his work.

The tuft sank away. This was far easier than the four-day climb up Dalton-Quinn Tree. A flock of small birds was veering wide of the trunk. "Harebrains," Ordon said. "Good eating, but you have to use the carm to chase them down. The old Scientist used to let us do that. Klance won't."

A streamer of rain was blowing across the out tuft. Was that why the First was so eager to move the tree? Wet citizens?

A mobile tree: it boggled the mind. Find your own weather!

A fluffy green bauble hung east of the out tuft, with a strange spreading plume of white mist behind it. Within a day or two London Tree would have put it from sight. The Grad wondered if he was being unreasonably antsy. The carm could reach Carther States across any distance. If he couldn't capture the carm, he would be here forever; and if he could, what was the hurry?

But time had a choke hold on his throat.

Life was not intolerable for the Scientist's Apprentice. In a hundred sleeps he might grow into this new life. When the time came he feared he would move too slowly, or not at all.

Clave found Merril in the Commons. She was dipping the points of crossbow bolts in the evil-smelling brew the Carthers made from poison fern.

The increasing tide caught Clave jumping toward her. He paused, then floated back, laughing. "It's real! I sure wasn't going to call her a liar, but—"

"Clave, what's *happening?*" Merril was drifting too, arrows all about her. She managed to catch the poison pot and cap it before it spilled.

"We're on our way. The warriors are on the surface." Clave jumped to his pack against the pull of the strange tide. He had readied it some sleeps ago.

Merril barked, "*What?* How long have we got?"

She had spent her days learning how to make arrows, twist bowstrings, shape a crossbow, and fire it. Clave had watched her at target practice. She was as good as most of the Carthers, and her powerful arms were faster at resetting the crossbow.

He said it anyway. "Merril, you're in Carther States whether you go or not. A lot of Carthers aren't citizens."

"So?"

"You don't have to go."

"You can feed that to the tree, O Chairman!"

Clave shoved a handful of the freshly poisoned bolts into his quiver. "Then grab your gear and go!"

The tide was about like that in Quinn Tuft. Using the tunnels was almost like walking. But it was *strange*. Every branchlet and foliage tuft had the tremors.

Clave pulled himself through crackling branchlets and soft green turf, through to the sky. A column of cloud raced outward from beyond the jungle's horizon. The surface was nearly vertical. He took care for his handholds.

Skeletal warriors emerged like earthworms out of the green billows. Fifty or sixty Carthers had already chosen and boarded pods. Clave was annoyed. The Sharman had told him late, and nobody had told Merril. Why? To give them a chance to back out? "Sure I'd have

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fought, but I didn't get the word in time—''

Maybe the Carthers needed copsiks more than citizens.

He helped Merril through the foliage. The light of battle was in her eye. She said, ''The copsik runners left us behind. Not worth their time.''

''I had a broken leg.'' Clave got it then, and hid his grin. ''They made a terrible mistake leaving you, though.''

''They'll find out. Don't you laugh!'' She shook a harpoon; its point was stained with evil yellow. ''This goop will drive you crazy if it doesn't kill you.''

The sky was a vast sheet of cloud. Lightning flashed in dark rifts. Clave searched the western fringe until he found a thin line of shadow. London Tree was too big to hide in a cloud: fifty klomters or so, half the length of Dalton-Quinn, but five times the long axis of this puffball jungle.

The Comlink's chosen leader, Anthon, already had his legs wrapped around the largest pod. Anthon was brawnier than the average Carther man, and darker. To Clave he might have had a fragile look, with long bones that could be snapped at whim. But he was festooned with weaponry, crossbow and bolts and a club with a knot on the end; his nails were long and sharp; scars showed here and there on his body; and in fact he looked savage and dangerous.

The stem-ends of the jet pods had been pierced by wooden stakes that now served as plugs. A warrior would nestle into the inner curve of the pod and move his weight to guide it. Clave had used up a few pods practicing.

There were more pods than warriors, a hundred or so spaced wide apart and tied down with light line. Merril chose one and boarded it. Clave asked, ''Shall I tether you?''

''I'll handle it.'' She swung her coil of line below her and caught it coming up. Clave shrugged and chose his own pod. It was bigger than he was, but less massive: thirty kilos or so.

Men outnumbered women, but not by a lot. Merril said, ''Notice the women? You *fight* for citizenship in Carther States. A citizen makes a better wife. The family gets two votes.''

''Sure.''

''Clave, how are they *doing* this?''

''Classified.'' He grinned and ducked the butt of her harpoon. ''I can't tell you everything. The Sharman says the jungle will pass the tree at an angle, about midpoint, with a klomter to spare. By then we'll have launched. We'll match speed with the tree and come in while they're still terrified.''

''How do we get back?''

''I asked that too.'' Clave's brows furrowed. ''Lizeth and Hild are bringing extra pods. They'll hover in the sky till they see the battle's over . . . but they'll just be caught with the rest of us, if the copsik runners use the carm. We've *got* to take the carm.''

''What are we trying to do, exactly? I mean you and me.''

''Gather Quinn Tribe. We want to look good to Carther States, but Quinn Tribe comes first. I wish I knew where they all are.''

Mist was drifting over them, seeping into the foliage. A wind was rising. Storm blurred the sky. He kept his eyes on the faint, shadowy line of London

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Tree . . . which was nearer, and growing.

The out tuft was nearest, the citizens' tuft. Citizens would be first to see the oncoming terror: a green mass klomters across flying at the trunk; green warriors coming out of the sky. Not much chance of surprise here. The jungle too was too big to be hidden.

Realistically, they hadn't a ghost of a chance of rescuing anybody. They would do as much damage as possible, and die. Why not attack the out tuft first? Kill some citizens and they'd remember better.

Too late now. The Sharman was klomters away, tending a pillar of fiery steam, aiming it to send the jungle a fingernail's-width from the tree. Fat chance of getting to her with a change in plan!

The line within the fog had solidified into a tremendous integral sign tufted at the ends. Every Carther now held a sword. Clave drew his.

"Warriors!" Anthon bellowed. He waited for silence, then cried, "Our attack must be remembered! It's not enough to break some heads. We must *damage* London Tree. London Tree must remember, for a generation to come, that offending Carther States is dangerously stupid. Unless they remember, they will come when we cannot move.

"Let them remember the lesson!

"Launch!"

Sixty swords slashed at the lines that tied them to the jungle. Sixty hands pulled the plugs from the stem-ends of sixty jet pods. Pods jetted away in a wind that smelled of rotted plants. At first they clustered, even bumping into each other. Then they began to separate. Not all jet pods thrust alike.

Clave clung with arms and legs, tight against the screaming pod. He was wobbling a little, more than the others. Unskilled. Blood was draining from his head. The tide was ferocious.

The sky was dark and formless, and lightning flashed nearby. They were approaching the center of the tree, as planned. There at the midpoint was the carrier, its nose against the trunk. Its tail was on fire.

Lawri tapped the blue button in a row of five.

Blue numbers flickered and steadied in the bow window. Blue lights appeared in the panel below: four clumps of four little vertical dashes each, in diamond patterns around a larger vertical bar. The array tickled at the Grad's memory. Lawri's hands hovered like Harp about to play.

"Strap in," Klance said. Lawri looked back in annoyance, then tapped rapidly. The Grad got it then. He was in a chair when the carm roared and trembled and lunged.

Tide pulled the Grad back in his seat, then eased off. (It hadn't mattered in Quinn Tuft, but the Scientist had drummed it into his head. Not tide! This was thrust! It might feel the same, but causes and consequences were different. The dead Scientist's legacy: *thrust!*)

The bow window nestled snug against the trunk. A breeze had sprung up; eddies swirled through the airlock doors. The Grad couldn't see anything of import through the side windows.

Lawri activated green patterns and tapped at them. Within the bow window

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appeared a smaller window, in which an edge of sky peeped around a glare of white light. An aft view within the forward view: disconcerting.

Klance was going for a better look. He made his way to the airlock, gripping chair backs as he went. The Grad followed. A few kilograms of tide . . . of thrust took the vibrating walls forward, past him, till he hit the aft wall with a solid thump.

Klance was braced in the outer door, all of his fingers and toes gripping the rim. "I'll let you see in a minute, Jeffer. Don't fall out. You might not get back." He craned his head out. "Damnation!"

"What is it?"

"It's the jungle. I had no *idea* they could move the jungle! Hah. We'll give them a surprise. We'll just move away from them." Klance grinned over his shoulder. He saw the Grad brace himself, too late.

The Grad's foot lashed out and caught the Scientist above the hip. Klance yelled and flew outward. Long fingers and toes still clung. The Grad's heel smashed at a hand and a foot. Klance disappeared.

He moved into the outer door and leaned out. The drive screamed in his ears.

The tree was massive, but it was moving. Klance drifted slowly aft, thrashing, trying to reach the nets on the carm's hull. In his terror he seemed to have forgotten his line. He saw the Grad leaning out, and shrieked at him: curses or pleading, the Grad couldn't tell. He looked away.

The tree now had a slight curve to it, like Minya's bow. The carm thrust in the center, and the tufts trailed behind, not very far. A stronger thrust might break the tree in the middle. But the carm was so much tinier than the tree; it was probably thrusting at full power now.

Klance was a thrashing black shadow against a brilliance like Voy brought close. The carm's main motor sprayed blue-white fire, pushing the carm forward against the mass of the tree. Klance was floating into the flame.

Ordon, halfway to the elevator, had seen them.

The jungle had become half the sky. Scores of objects moved alongside it: shapes like those he'd seen before the bark raft crashed into the jungle. Jungle giants on jet pods! But they wouldn't arrive if the carm continued to push the tree away. He had to turn off the main motor, now!

So he *hadn't* been premature, *hadn't* murdered Klance for nothing.

Lawri! He re-entered the carm and leap toward the bow. Lawri hadn't seen him. She stiffened suddenly and half rose, staring aghast at the rear window-display. A shadow was thrashing in the flame, dissolving.

She whirled about. She was staring him in the eye when the Grad lashed out at her jaw.

Her head snapped back; she bounced against her straps and hung limp. The Grad used his line to tie her to one of the chairs. He sat down at the controls and studied them.

Yellow governed life support systems, including interior lights and the airlock. Green governed the carm's senses, internal and external. Blue had to do with what moved the carm, including

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the motors, the two flavors of fuel supply, the water tank, and fuel flow. White read the cassettes.

What had Lawri done to activate the drive? His mind had gone blank. He tapped the blue button. No good: the blue displays disappeared, but the motor's roar continued. He restored the display.

Through a side window he glimpsed patches of Navy blue cloth moving across the bark. *No time. Think.* Blue vertical bar surrounded by blue dashes . . . in a pattern like the motors at the stern. He tapped the blue bar.

The roar and the trembling died to nothing. The tree recoiled: he felt himself pulled forward. Then it was quiet.

Kendy was prepared to beam his usual message when the source of hydrogen light disappeared.

That was puzzling. Normally the CARM's main motor would run for several hours. That, or the attitude jets would send it jittering about like the ball in a soccer match. Kendy held his attention on a drifting point within the Smoke Ring maelstrom, and waited.

A dozen Navy men were making their way toward the carm, using lines and the lineholds, wary that he might start the drive again. Ordon was far ahead of the rest, mere meters from the window. There was murder in his face.

Quick, now! Hit the yellow button. The display was too cluttered: turn off the blue. Yellow display: interior lights showed *dim*, internal wind *on*, temperature shown by a vertical line with numbers and a notch in the middle; here, a complicated line drawing of the carm's cabin seen from above. The Grad closed lines that should represent the doors, with a pinching motion of his fingertips. Behind him the airlock sealed itself.

Lawri stirred.

He heard muted clanging from the doors.

The Grad began playing with the green displays, summoning different views from the carm's cameras. He had precious little time to learn to fly this starstuff relic. He felt Lawri's eyes on him, but would not look.

The clanging stopped, then resumed elsewhere. Ordon snarled through a side window. He must be clinging to the nets, pounding at the glass.

The Grad moved to the window. He spoke a word. Ordon reacted— puzzled—he couldn't hear. The Grad repeated it, exaggerating the motions of his lips, the word that would justify murdering his benefactor Klance, assaulting Lawri, betraying his friend Ordon, leaving London Tree helpless against attack.

"War, Ordon! War!"

CONCLUDED IN NEXT ISSUE

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● Isn't it interesting that the same people who laugh at science fiction listen to weather forecasts and economists?

Kelvin Throop III

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Jay Kay Klein's biolog

When Larry Niven started selling stories in the mid '60s, he was told by supreme technologist and futurist John W. Campbell that he should start a career and consider writing a hobby because there wasn't much money in science fiction. By now, Larry has helped make history by receiving publicized six-figure contracts for his widely sought novels. As Fred Pohl says, the future isn't the way it used to be.

Strangely enough, Larry's writing still probably brings in the smaller share of his income, since his grandfather and namesake also made history—by discovering oil in Los Angeles. Edward Laurance Doheny and his partner spotted a horse-drawn cart filled with something black that the driver said was tar. It figured there would be oil in the area, and they bought property in the La Brea Tar Pits area. As experienced gold miners, they dug down some 150 feet with pick and shovel before the noxious gases bubbling up compelled them to seek help from higher technology. Larry figures a few more feet of digging and he'd never have been born.

Larry Niven

Larry saw the light of day in Los Angeles and was raised in Beverly Hills. He spent two years at Caltech, but devoted more time to science fiction magazines than textbooks. He received a B.A. in mathematics with a minor in psychology in 1962 from Washburn University in Kansas. A year's graduate work in mathematics at UCLA followed before he quit to write full-time. His first published story appeared in 1964 in a now-disappeared magazine. Five years later he married a fellow science fiction reader who has been called by Dr. Marvin Minsky (a world figure in cybernetics and science fiction fan) one of his best graduate students.

A versatile writer, Larry has turned out stories as brief as 700 words and as long as 250,000, and has done TV scripts and even continuity for a newspaper comic strip. He is able to write completely alone or harmoniously with a collaborator, most notably Jerry Pournelle. One series of novels waiting for writing time will be based on worlds created with seven other writers.

Larry says that science fiction writers don't actually try to stay ahead of science, but follow as closely as possible behind the scientists, looking over their shoulders at what's ahead.

Considered among today's leading "hard science" writers, he likes to work out the figures correctly for everything he does, if need be checking with world-class scientists for the best insights into areas that are, after all, beyond the leading edge of today's knowledge. Typically, and unusually, Larry mixes hard physics with speculative biology and has come up with some of science fiction's most intriguing aliens and eco-systems. ■

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the reference library

By Tom Easton

Creating Peace: A Positive Handbook, L. Langdon, Larry Langdon Publications (34735 Perkins Creek Road, Cottage Grove, OR 97424), $3.95, 64 pp.
Spellsinger, A.D. Foster, Warner, $2.95, 347 pp.
Life Probe, M. McCollum, Ballantine/Del Rey, $2.95, 304 pp.
Code of the Lifemaker, J.P. Hogan, Ballantine/Del Rey, $13.95, 320 pp.
Navigator's Sindrome, J. Carr, Doubleday, $11.95, 188 pp.
Sky Ripper, D. Drake, TOR, $3.50, 352 pp.
Uller Uprising, H.B. Piper, Ace, $2.75, 187 pp.
Compounded Interests, M. Reynolds, NESFA Press, $13.00, 161 pp.
The Wild Alien Tamer, M. Resnick, Signet, $?, 192 pp.
Pulp Voices or Science Fiction Voices #6, J.M. Elliot, Borgo Press, $?, 64 pp.
The Hopeful Future, G.H. Stine, Macmillan, $16.95, 238 pp.

Last month I promised to say a word or two about some "World Peace" literature that was on its way to me. Here it is: **Creating Peace: A Positive Handbook**, self-published by Larry Langdon. He first wrote me to complain that all SF writers seem to agree that the future will still know war and that too many stories rely on war for story conflict. He insisted that there were alternatives, such as the many ways of "waging peace," and suggested that by reviewing his book I might do my bit to encourage a peaceful future.

I'm all for it. War makes jobs, and it boosts economies and technical innovation, but it is inevitably a bloody, wasteful disaster. I would love to see it vanish from the human repertoire—and perhaps even from SF, although it is possible to argue that fictional war teaches readers to be wary of the real thing, and although there *are* plenty of non-war SF stories. *But* Langdon's little

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book doesn't seem to be the way to extinguish war. The writing is fairly crisp and clear, but it is also simplistic. For instance, Langdon suggests that the Russians would not bomb us if we could get them hooked on our TV shows; if "The Russian people know that we are so wonderful that if we took them over they would be happier than they are now" (a delightfully chauvinistic idea, of precisely the sort that leads to war!); or if "The Russian people refused to give their leaders the power to wage war without their permission" (*first*, they have to take that power away!). More to the point might be the general realization, in both U.S. and U.S.S.R., that it would be better to live under foreign, "enemy" rule than to fight a war.

Langdon offers some good ideas, most of them centering on the value of increased personal contact between nations, and a few tidbits of useful information. However, he ignores the causes of war and seems to know very little of the relevant biology, psychology, and sociology. His book's greatest value may be as a directory of peace groups, although it could also serve admirably as a textbook example of unrestrained and feverish idealism.

Sorry, Larry, but I calls 'em as I sees 'em. Like many SF writers and others, I do believe war will persist even in an equitable and friendly world, for there will always remain ideological ambition and paranoia, as well as the megalomania of rulers and the hurt feelings of history. I strongly suspect that the best we can do is to keep the inevitable conflicts small and local.

With that out of the way, I can get down to the pleasant business of stroking authors whose books have pleased me. First in line is Alan Dean Foster, with **Spellsinger**, which will have at least one sequel. He posits a world of magic, but not quite of fantasy, for the "magic words" of spells are here ones we recognize from our own context:

> "Terra bacteria,
> Red for muscle, blue for blood,
> Ruination, agglutination, confrontation,
> Knit Superior.
> Pyroxine for nerves, Penicillin for curds.
> Surgical wisps, solvent site, I bid you complete your unguent fight!"

That one's a healing spell.

In other words, Foster tells us that science is no more than a brand of magic, complete with its own incantations and magical formulae. He doesn't do a lot with the notion, but it adds a fitting (if faintly insulting to scientists) note to a colorful and wacky story of a civilization of intelligent warm-blooded animals, among whom humans are a minority, threatened by a culture of giant insects (the Plated Ones) with the voracious mind-set of army ants.

The Plated Ones have found a powerful magic of their own, and their threat is more real than ever before in history. An elderly wizard, a turtle yclept Clothahump, seeks a defense from the home world of the insects' magic. He wants a wizard; he gets a pre-law student and would-be rock musician named Jonathan Thomas Meriweather. Jon-Tom, as the locals dub him, is a bumbling innocent who only slowly discovers that he is in fact a wizard, of the sort who makes magic with music; he is a spellsinger. Then, together with Clothahump, the otter Mudge, the bat Pog, and two human women, he sets out to raise the countryside to do battle with the Plated Ones. Their success remains for later volumes, of which *The Hour of the Gate* will be next.

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Spellsinger is fun, and I enjoyed it. I fully expect you will too.

Michael McCollum's **Life Probe** concerns what happens when an alien spacecraft comes to Earth, sent ages ago by a species that wants to learn the secret of faster-than-light flight but has been unable to find it on its own. It thus packed its knowledge into a host of probes with the mission of finding intelligent life forms and cross-fertilizing them. When a probe finds a sentient species, it offers all the knowledge it carries in exchange for refurbishing and refueling.

To the Life Probe, humans seem a marginal case, suspicious and secretive despite their presence throughout the solar system. But on its approach, it registers signs of ftl travel some light-years beyond, and it must refuel if it is at last to find its grail. It opens negotiations, and its offer is accepted despite the attempts of the Pan-African leaders to block the deal. The Pan-Africans believe that an infusion of new knowledge and technology will only reinforce the dominance of the industrial nations, leaving them at the bottom of the heap forevermore. As the probe settles into orbit and the humans begin to confer with it, they mount a dog-in-the-manger attack that cannot fail.

Do the Pan-Africans succeed in destroying the probe? Buy the book and find out for yourself. I won't say, except to promise you an enjoyable interweaving of threads, interesting characters, and a future that could really come to pass. McCollum's world is one we may well be heading toward. It rings true, with the only novelty we have to work to swallow being the use of miniature black holes for space drives. Such drives are becoming standard furniture in current SF, despite the problem that tiny black holes seem too unstable to exist. We can thus accept them just as we have long accepted blasters and warp drives, comforting ourselves with the thought that they make at least a little more sense.

In James P. Hogan's **Code of the Lifemaker**, we find a very different approach of aliens to the solar system. In the days of the australopithecines, a world ran short of raw materials. It solved its problem by sending self-reproducing, self-programming robot mines and factories to other worlds to extract raw materials, process them into goods, and ship them home. However, one of the robot ships was scrambled by a supernova's radiation. "Mindless," the ship landed on the first half-way-acceptable world it came to—Titan. Then evolution took over, until Titan was occupied by an ecology of mechanical creatures, including sentients.

When a human probe lands on Titan, it is promptly eaten (read: dismantled) by the beasts of the Titanian forests. Humans are thoroughly alarmed by the pictures returned of the process, and they mount a mission to contact the sentients behind the "robots." The mission's real purpose is secret, but on it is the psychic Karl Zambendorf, a fraudulent showman with a talent for putting together tidbits of ferreted information and revealing his conclusions to the great discomfort of others.

Zambendorf is a deceitful trickster of engaging cynicism. He knows so many of the gimmicks exposed by James Randi and his ilk that Hogan must subscribe to the *Skeptical Inquirer*. Yet he is also the hero of a very high-tech tale, for when the mission finds the truth of Titan, he is the one who earns the natives' trust, and when the mission's masters begin to plot a Machiavellian

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colonialism, he is the one who queers the pitch by introducing a religion of peace, complete with miracles.

Hogan paints an intriguing robotic ecology and culture on Titan, but the book's real power lies in Zambendorf. The psychic defends his activities on the grounds that people are chumps: they've had their chance to choose rationality; if they choose its opposite, then who is he not to give them what they want? On Titan he finds a people who, given a shot at genuine mental stimulation, seize it avidly. Being who and what he is, Zambendorf is admirably equipped to give them too what they want, and in the end the direction of his life has changed drastically.

Hogan's prose is as workmanlike as ever, and he is as prone to lengthy lectures. Yet the story moves well, holds the interest, and satisfies in its conclusion that even those who seem most intellectually bankrupt can find solvency.

Jayge Carr's **Navigator's Sindrome** is a very different tale. On Rabelais there is no law but that of contracts, and to be under contract to another is to be a slave. Rabelais's masters are the contract-holders, or c'holders. Too many of them are devoted to satisfying the most vicious of appetites, and they have their panderers. One such c'holder is the Lord Golden Singh. His panderer is Zaqanna, tender of the Gilded Cage bar. When Singh decides he wants the Navigator Jael, to break and tame and destroy, Zaqanna engineers a plot that will let him accuse her of contract-breaking, and thus get her under contract for Singh.

All goes as planned. But the Navigator's Guild protects its own, and forces move, even among the Rabelaisians, not all of whom are as depraved as Singh. In the end, Jael escapes. In the process, we witness an intricate imagination at work. Carr has a gift for character, and she exercises it constantly.

I enjoyed *Sindrome*, though I found it something of a jumble. It has no single hero or focus, but a throng of honorable men and women, few of whom act in collusion. They each oppose Singh and what he represents. They act as much against him as for Jael. They thus confuse the reader, but they also give the tale a taste of the sweep that marks history. Carr's villains are far more single, although they still stand for a class and system of evil. They have numerous unseen cohorts in the wings.

Evil is thus monolithic. Good is diffuse. But good can win. Weakness can defeat strength. The key is the persistence of water against rock, along with the faith of each drop of water that it is not alone.

Sheesh! I wax exceedingly portentous. But if I need an excuse, I can find it in Carr's closing lines, where she makes precisely this message explicit and turns her whole novel into a morality play. Some readers will think she thus weakens her tale. Given the task she set herself, I think she does not. The homily closes the tale quite effectively and helps to bring sense out of confusion. The total effect is such that I can boldly proclaim that *Navigator's Sindrome* is one of the better and more ambitious books of the year.

David Drake's **Sky Ripper** is espionage adventure, barely SF at all. Ex-agent Tom Kelly is brought back to active duty to help the Soviet physicist Emil Vlasov defect while attending a conference in Algiers. Vlasov is loyal to the U.S.S.R., but he has designed an antimissile particle beam powered by thermonuclear explosions which his own

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nation cannot engineer. Furthermore, he hears voices that tell him Earth is about to be invaded by aliens. His weapon is Earth's only hope. To save his own country, he must defect. Yet his masters are possessive and, he believes, the aliens too are out to stop him.

Kelly's job is to pry Vlasov loose. The U.S. wants his secret, though it thinks the man more than a little crazy. Kelly's tactics, developed between dalliances with the ambassador's wife, involve a firefight in midtown Algiers. When things go wrong, the story develops into a chase across the countryside, all adrenalin and no intelligence. It ends happily, and there is a neat twist that reinforces the SF component.

Perhaps Drake had Hollywood or TV in mind. Certainly, the story has enough violence, gore, sex, and action to make a hit. On paper or on film, it's an active romp, good fun, an evening's entertainment. What it doesn't do is create memorable characters, challenge cliches, or offer novel ideas.

Uller Uprising completes Ace's republishing of the works of H. Beam Piper. Set on a world of barbarian aliens dominated by a Terran corporation, a scene strongly reminiscent of British imperialism and in fact based on the British presence and disaster at Cawnpore, it presents the Terrans with a rebellion. The Terrans squelch the rebellion at great cost and assume the proverbial paternalistic Burden.

So what's so great about the tale? For one thing, Piper's Terrans aren't real happy with the way things turn out. They see their mission as uplift, not custody or exploitation. For another, *Uller* was new in 1952, well before the rise of anti-imperialist and anti-colonialist fervor that has marked the last two decades of world history. Piper's point is that sometimes the uncivilized do act like yahoos and need guidance and supervision. When they do not, they deserve and should get better treatment, as do his Kragans, ex-bandits who have embraced the philosophy of civilization as well as the benefits the yahoos drool over. Here, then, is a message for the present, when we tend to treat the world's yahoos far better than they deserve. (Don't we?)

Mack Reynolds never made it to Boskone XX last February 18. He was scheduled to be the guest of honor there, but he died of cancer on January 30. Nevertheless, the NESFA Press brought out the commemorative volume it had planned to honor his GoH-ship; since the book makes no mention of Reynolds's death, we can presume it was printed and bound before the news arrived. NESFA printed only 1000 copies of the book, 200 of them slipcased and autographed by Reynolds and the cover artist, Wendy Pini.

Compounded Interests consists of an introduction in which Reynolds tells why he lived in Mexico for so long; "Idealist," a story he wrote just for this book; one short poem; and ten stories, at least some of which have not been collected before. Several of the stories I remember fondly from their appearances in this and other magazines. Others I recall once I've read them again. A few are new. All are good, with the typical Reynolds provocativeness. If you can get the book, treasure it. I plan to, and only partly because it must already be a collector's item.

Mike Resnick's third Tale of the Galactic Midway is **The Wild Alien Tamer**. Thaddeus Flint's carnie is touring the hick worlds of the galaxy, a route Flint discovered after he kidnapped a flock

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of alien tourists disguised as a uniquely successful freak show back on Earth. By now Flint's operation is a success, thanks to his learning the universal appeal of the classic grifts. Yet even greater success awaits.

Resnick prefigures his tale with one of two collies that roundly hate each other. They are constantly at each other's throats until the day their owner puts them together to fight it out. They do, and thereafter they are the best of buddies. (It may even be that Resnick is the owner in question, for he does breed and exhibit show collies.)

The dog story doesn't quite match *Tamer*, but it comes close. Jupiter Monk, the carnie's animal tamer, has lost his Terran animals, which could not stand the constant shifts in environment and diet. To replace them, he seeks alien beasts, and he comes up with an intelligent alien who resembles a giant bat. The two strike a deal: on worlds whose natives most resemble Monk, he will be the animal tamer and put Batman through his paces. On worlds whose natives most resemble Batman, *he* will be the tamer and put Monk through his paces.

Driven by economic inequity (Monk gets most of the loot), pride (who wants to be a beast even half the time?), and anger (those whips hurt!), the two really get into their macho game. The show's cage becomes a metaphor for life as they take turns trying to beat each other into crying, "Uncle!" with whip and club and fist. They draw blood and maim and scream, and the audiences love it. So does the reader, for Resnick renders the scenes and their entr'actes hilariously, and he makes it clear that the wild alien tamer of the title is neither Monk nor Batman.

I loved the story. I chuckled and laughed and roared. I was ready to hand Resnick the first set of laurel twigs I could lay hands on—until I came to the end. There he hands his pair of sadomachoistic competitors quite a comedown—or splash-down—by turning them into clowns. He mocks and vitiates their pride and heroism with an exceptional thoroughness. If we look at it one way, Resnick pissed his story away for the sake of a sad, bad joke. If we look at it a little differently, he has such a low opinion of the psychology of "manliness" that he considers it a joke in its own right. I like the latter better, but I do wish he had devised a more satisfying ending.

I have before me one more in Borgo Press's Milford Series, **Pulp Voices or Science Fiction Voices #6**, offering interviews with Jack Williamson, H.L. Gold, Stanton A. Coblentz, C.L. Moore, and Raymond Z. Gallun, all conducted by Jeffrey M. Elliot. The book also has an introduction by Poul Anderson.

The interviews are informative and interesting, largely thanks to their subjects. Elliot is no Charles Platt, to bring person and scene alive for a reader. Nor is he as punctilious a scholar as he might be. Coblentz died long enough before publication that Elliott should have squeezed in a note to that effect.

In **The Hopeful Future**, G. Harry Stine tries to persuade the world to get its collective ass in gear and make the SF future happen. He urges seven "macroprojects": planetary cleanup; universal education; universal opportunity for food, shelter, health care, and energy; elimination of disease; life-extension to 200 years or more; stimulating, useful jobs for all; and access to the ultimate frontier in space. He shows how all seven can be accomplished, and he makes a persuasive case. It is but a minor flaw, inherent to some extent in

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the delays of the publishing process, that his data aren't always up to date—the last price I saw for biomass oil was $50–100, not $20, per barrel. I do balk just a bit, though, when he gets excessively optimistic, as when he projects "*a* prevention and *a* cure for all observed and known forms of cancer" (my italics). I balk even more when he starts breathing heavily about psionics, for despite my own inclinations to wonder, books I have read and reviewed in this column make it seem quite likely that Stine has fallen for flummery.

But the psionics is only one chapter. The rest of the book is a sales pitch for the shiniest and most promising of high-tech 21st centuries. Read it to prepare yourself or convince yourself. Recommend or give it to your anti-science, anti-progress friends. Urge it on your local library. ■

IT'S ANLAB TIME AGAIN!

This issue completes 1983 for *Analog*; now it's time for you to let us know how we're doing. The authors are interested, I'm interested, and you should be interested—because your feedback about your likes and dislikes will have a second-order feedback effect on what we offer you in the future. So please vote. Here's how:

Look over all your copies of *Analog* dated 1983, or refer to the Index to 1983 which will appear in our next issue. Pick your *three* favorites in each of the following categories: serial, novella/novelette (a single category), short story, science fact article, and cover. Then drop us a line listing your choices, in order of preference. We'll tabulate the votes and let you know how they came out.

Please note: Dr. Robert L. Forward's *Rocheworld,* which concluded in the February issue, should be considered among this year's serials, along with *Manna* by Lee Correy and *The New Untouchables* by Joseph H. Delaney. (Larry Niven's *The Integral Trees,* which concludes in our next issue, will count as a 1984 serial.) And "The Blivit in the B-Ring," a two-part science fact article which ended in January 1983, should be considered a part of this year's competition. (Those of you who included it in your 1982 picks, take note!)

Send your votes to: AnLab, *Analog,* Davis Publications, Inc., 380 Lexington Ave., New York, NY 10017. They must be received by February 1, 1984.

—The Editor

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brass tacks

Dear Dr. Schmidt,

It cannot be said you don't have guts. I've just finished reading Timothy Zahn's "The Final Report on the Lifeline Experiment," and I'm sure by the time this letter reaches you you will have already taken hits from both sides of this issue. I'm one of those who is not decided on the question, seeing problems and attractions to each point of view. Congratulations on bringing the problem up in *Analog*.

With reference to your editorial, I would point out that the term "Right to Life" applies not only to those with a particular reference on the abortion issue, but to those who would prolong the life of compromised adults and children. There are folks who would perform heroic resuscitations on those who are dying of cancer—and believe me, I've seen this done numerous times. There is also the recent ruling that hospitals must support the lives of deformed infants, even those (presumably) who are born with anencephaly, or no brain. Although this condition is not uncommon, it is not widely known because these kids don't survive for very long. How long should children without kidneys, brains, major portions of intestines be supported if there is not at this time the technology to deal with their illnesses? To what extent should those who have no realistic chance of survival be subjected to the cutting edge of life support technology? More appropriately, to what extent should the United States government, or state and local government, impose regulation in issues which have not the benefit of a clear public consensus, or impose blind bureaucratic rules to circumstances in which there are individual considerations? I am a Family Practice physician, and an instructor in the use of those advanced life support techniques to

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which I alluded earlier. I don't know the "right" answers to the moral questions, but would rather that the government keep out of questions in which individual judgment is needed. It would be easier if everybody had the world figured out as clearly as do Mr. Reagan and Surgeon General Koop, but I suspect that most of us are not so blessed.

ROBERT B. MCCOWN, M.D.
3620 Zia Drive
Gallup, NM 87301

Dear Stanley,

Oh, my. Haven't we opened up the Pandora's box with your May issue! O.K., I'll bite. I'm a new subscriber, and very active in the movement to criminalize abortion. I'm impressed with your courage in dealing with the abortion controversy in your editorial and in printing Timothy Zahn's "The Final Report on the Lifeline Experiment."

Zahn's story was excellent, but not from the pro or con side of the abortion picture. It was just plain good science fiction. His point seemed to be that a) if the issue is not so much whether there is life in the womb from the moment of conception, but whether that life is "human," then b) any attempt to ascertain its "human-ness" experimentally changes it somehow, a derivation of the Heisenberg uncertainty principle.

A weakness in Zahn's argument is that if indeed "human-ness" is altered by the act of ascertaining such a quality, then we are only talking about *degree* of "human-ness." Something that is not human to begin with obviously cannot have its human-ness altered—as it apparently was in Zahn's story—even in the case of the five-week-old fetus.

When Dan (in Zahn's story) said, ". . . shouldn't the law reflect medical realities wherever possible?" I said to myself, "Right on!" We don't make laws based on metaphysical concepts. That is why your editorial puzzled me, Stanley. Your proposal was basically "If it doesn't *look* human, why give it human rights?" The Earth looks flat from where I stand, but I know from scientific facts that it is round. I am surprised that you, a scientist at heart, would make such an unscientific statement!

In medieval times, "quickening" was thought to be the beginning of human life. Thanks to Leeuwenhoek et al, we know differently. The medical facts are that at *no* stage in the development of a fetus does it resemble that of another species (except in appearance, of course). No other species has 46 chromosomes that I am aware of.

So there need not be discussions about "soul." That is metaphysics, and metaphysics has no place in making laws. The medical facts have been known for half a century, and until the '60s our nation's laws reflected those facts.

The very fact that no one can determine when a human being becomes a "person" dictates that our laws should *protect the possibility* at all stages of development. Is it not characteristic of civilized countries to give life the benefit of the doubt? We have given individuals the right to be executioners, to determine that there are *degrees* of value in human life. The pro-abortionists cry, "Is it just to bring a deformed child into the world, or a child whose parents will likely abuse it?" I would ask, "Is it just to kill an unborn human who may have loved his/her life in spite of his/her physical attributes or social circumstances?"

We give no second thought to the nature or "quality" of the life of a person who has just been murdered. Without exception we arrest his murderer and place him before a judge to account for

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his actions. The only difference between abortion and murder is that, in abortion, the individual has not yet passed through the birth canal. And on that distinction we base our laws. As Dan said (in Zahn's story), "Those people who want to believe the first breath is the dividing line are fooling themselves."

When does a person become a person? Who knows? My wife's grandfather is senile, incontinent, and going blind. Does that give anybody but him the right to judge the "quality" of his life? "A person is more than just his mind," says Susan. Once we have determined that an individual is a living, breathing, biologically human being, we have no right to make judgments about the "quality" of his/her mind, or the quality of his/her life.

My point is, the unborn human is unquestionably human, it is unquestionably living, and has been shown to possess learning capabilities and personality traits long before birth (that "magic" line); because we give every other unquestionably human individual the chance to grow up and further develop his or her uniqueness *after* that magic line of birth, should not our laws acknowledge medical facts and extend the full penumbra of human rights to those individuals who have not yet been born?

Question: If birth is the dividing line between protection by law and unprotection, at what point will protection be afforded the individual raised *ex utero*? Once again, it will not be long before technology dictates a re-thinking of our laws.

As an aside, the Heisenberg principle is generally associated with experimentation on inanimate matter. Zahn's experimental fetuses (from this anti-abortionist's point of view) were more likely subject to the parallel sociological principle of the Hawthorne Effect, which states that humans who know they're being observed react in a manner which somewhat alters the data progressing from the study. Either way, as Zahn states, "The experimenter influences the experiment."

CHUCK FISHER

Greeley, CO

To regard anything *as "unquestionable" is a good start toward tyranny. Analog will continue to be an idea forum in which* everything *can be questioned—remembering always that the act of asking the question does not* a priori *imply any particular answer.*

Analog Editor:

Your magazine is to be commended for publishing Joseph Goodavage's excellent article on astrometeorology (April) and for your prudent editorial comments about Goodavage's theories. As a professionally accredited scientific astrologer living on the central east coast of Florida where storms are playing havoc with the shoreline and with NASA's launches, I have been in an ideal position for the past four years to test and evaluate astrometeorology. And I can assure you, it does work!

If one is a skilled astrologer and has the time and the inclination to delve into the complex weather forecasting area, astrometeorology is invaluable. For example, it enabled me to predict far in advance for my clients and students the damaging storms along this coast in October and November of 1981 which caught local meteorologists completely off-guard.

Apparently frustrated by their inability to accurately predict the increasingly complicated weather patterns in this coastal region, weather forecasters now resort to issuing dire warnings whenever a perigean tide approaches. This occurred over the full moon weekend of

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February 27, 1983. Their predictions would have scored a bullseye for California, but the extensive flooding and damaging beach erosion they forecast for this location simply did not occur. The ocean here was actually calm, with tides no higher than normal. Flooding did not occur on the eastern beaches because the strong, gusty winds were from the west, and only someone familiar with the intricacies and details of astrometeorology would know that information ahead of time. On the other hand, astrological weather charts erected for the Southern California coastal area showed conclusively the type of winter storm destruction which developed there.

United States Weather Bureau forecasters and meteorologists state that —even with their sophisticated equipment and extensive satellite coverage —they cannot successfully predict long-range weather conditions. And they are right. They cannot.

But astrometeorologists can because they are using planetary calculations and a reliable forecasting method. That knowledge is available to scientists, most of whom, unfortunately, choose to ignore or dismiss it.

I concur with Joseph Goodavage's personal opinion that a major breakthrough will be scored by astrology through the field of astrometeorology. Until that happens, one thing is certain—the planetary alignment for the rest of this century will have meteorologists utterly frustrated, while astrometeorologists will continue to successfully forecast the extreme weather abnormalities we will experience in the 1980s and 1990s.

You are so right—let's establish that astrometeorology does work, start using it now and figure out how it works later.

GENEVIEVE WOLFSOHN, PMAFA
Satellite Beach, FL

Actually, I said let's establish whether *it works (I'm not fully convinced), and* if *the answer is yes, go on from there.*

Dear Dr. Schmidt:

Much as I enjoyed Dr. R.L. Forward's science fact article "Flattening Spacetime" in your March issue, I still cannot quite believe that "the Earth's gravity field is 300 times weaker at 36,000 km altitude" and that gravitational attraction varies inversely to the *cube* of the distance.

I'm looking forward to a science fact article revising Kepler's Laws.

V.N. MALINOV
Haifa, Israel

The article should have said "the tidal force due to the *Earth's gravity field . . ." or equivalently, "the Earth's gravity* gradient *field is 300 times weaker . . ."*

Dear Stan:

Now that the Shuttle is a working reality, why not prefabricated, flexible, foldable, plastic space-habitations that it can easily carry up into orbit in compact form—much as an airman carries his folded parachute—there to be released from the Shuttle's protecting cargo-bay, and deployed to their full size and shape simply by inflating them with breathable air?

The basic concept here dates back at least to 1960 when Echo One, a balloon of thin, metallized Mylar to be used as a passive radio-wave reflector, was rocketed into orbit, and automatically inflated into a hundred-foot globe by an attached bottle of compressed gas.

I expect that other readers of *Analog* have also noticed the much broadened possibilities of this same idea today, and wondered—*why not?* The thought fairly begs for attention. This is particularly so when it is contrasted with the con-

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ventional, popular notion of space-stations, etc., made of more solid materials, brought up in numerous loads from Earth's surface, and being tediously assembled in orbit by space-suited technicians struggling to cope for their first actual time with zero-G and other spatial conditions.

I lack detail-info about how much developmental effort, either civilian or military, is being applied to such inflatable space-use devices, but I do have the impression of short-sighted neglect, and even more short-sighted rejection.

If the desired structure is too big to be orbited as a single load, it might be made in joinable segments. Once a plastic shell is deployed, the solid details needed for any particular experiment or function would be added, again with relatively little fuss: life-support systems, attitude-control and even propulsive units, plus whatever devices are needed or wanted, for whatever test or function or other spatial activity that is intended. Solid bracing—where required —would also be installed.

Otherwise, the cross-section of the plastic material used might be similar to that of a car-tire, though much less massive. Nylon or fine-wire cording might be incorporated for added strength; also heat-insulating and self-sealing features, the latter to take care of leaks and meteoroid-punctures, though space-age history—satellites having orbited Earth for years, Apollo vehicles having gone to the moon several times, and deep-space probes having journeyed as far out as Saturn, usually without serious damage caused by meteoroids—indicates that their hazard is minimal.

It has been stated that our moon-landing astronauts and our sky-lab crews ran a much greater risk from the radiational effects of possible sudden solar-flares. But, as was, and over considerable time, they emerged alive and intact, though shielded only by thin metal of their habitats, no more than the equivalent of lead-foil, which might readily be added to the inside of a plastic structure. In any case, small, heavily shielded solar-storm shelters could be provided with no great difficulty, to handle such emergencies.

The basic idea of these plastic structures is old; it is not mine; I make no claim to it. I just believe in it, and want to draw attention to it, get it talked and argued around. Like that, action may be started, our space projects simplified, speeded up, made much less expensive and more appealing to the people in a time of budget-cuts—and a giant leap toward the Big Frontier gotten underway.

RAYMOND Z. GALLUN
110–20 71st Avenue
Forest Hills, N.Y. 11375

O.K., folks . . . comments? Suggestions? Ideas?

Dear Mr. Schmidt,

John Rowland's recent letter caught my eye. He commented on the difficulty of locating illustrations (and illustrators) in the back issues of your magazine. Mr. Rowland is probably not alone in his frustration at not being able to relocate memorable artwork. Science fiction fans have always appreciated the value of good artwork in their magazines (the Guest of Honor at the first World SF Convention was an artist, Frank R. Paul), but despite the recent upsurge in interest in SF art it is still difficult to find detailed information on published artwork in the genre.

A couple of years ago my friend Jerry Boyajian and I were complaining to each other about the difficulties we were having finding things in our own magazine collections, so we decided to do

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something about it. We put our heads together and started publishing a series of annual indexes to the SF magazines, including a retroactive set going back to 1977. Being active fans ourselves, we put into them every feature that we thought our fellow fans might want, including a complete and comprehensive list of artwork. We have tried our best to identify the artist for every illustration and several editors, including Stanley Schmidt, have been very helpful in answering inquiries about uncredited artwork.

Anyone who saves the back issues of his SF magazines, for whatever reason, will probably find our indexes useful. People who are interested can write to us at the address below and we will be glad to send them a list of what we have available.

KENNETH R. JOHNSON
TWACI Press
PO Box 87
MIT Branch PO
Cambridge, MA 02139 ■

IN TIMES TO COME

● In the monthly guessing game of "What's in the next issue?" the one thing I'm quite sure of this time is that our January issue will conclude Larry Niven's novel, *The Integral Trees*. And since that's such a thoroughly colorful story, we couldn't resist giving it a second cover, by Vincent Di Fate.

Elsewhere in the issue, if things go by plan, will be a story by Jerry Oltion which may look (at first glance) more familiar than it is, and another by James Gunn concerning a character who has appeared here before but doesn't remember it. The fact article, "Aliens Among Us," by Dr. Mark S. Lesney, offers a close look at the critters which humans use as the tools of genetic engineering. And Ben Bova has a brief but profound observation on a little-known principle of history.

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ISAAC ASIMOV'S SCIENCE FICTION MAGAZINE

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20–23 November
General meeting of the American Physical Society at San Francisco, Calif. Info: A.P.S., 335 E. 45th St., New York NY 10017.

25–27 November
Darkover Grand Council Meeting (specializing in the works of M.Z. Bradley and related authors) at Radisson Hotel, Wilmington, Del. Guests: Katherine Kurtz, Hal Clement, Don and Elsie Wollheim, Diana Paxson, P.E. Zimmer, etc. Info: Darkover Grand Council, Meeting 6, c/o Himmelsbach, 308 West Duval (1st floor), Philadelphia PA 19101.

25–27 November
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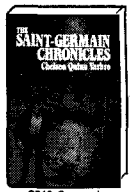

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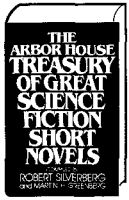

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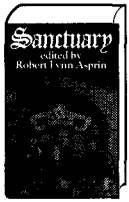

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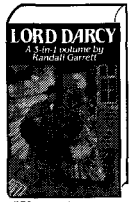

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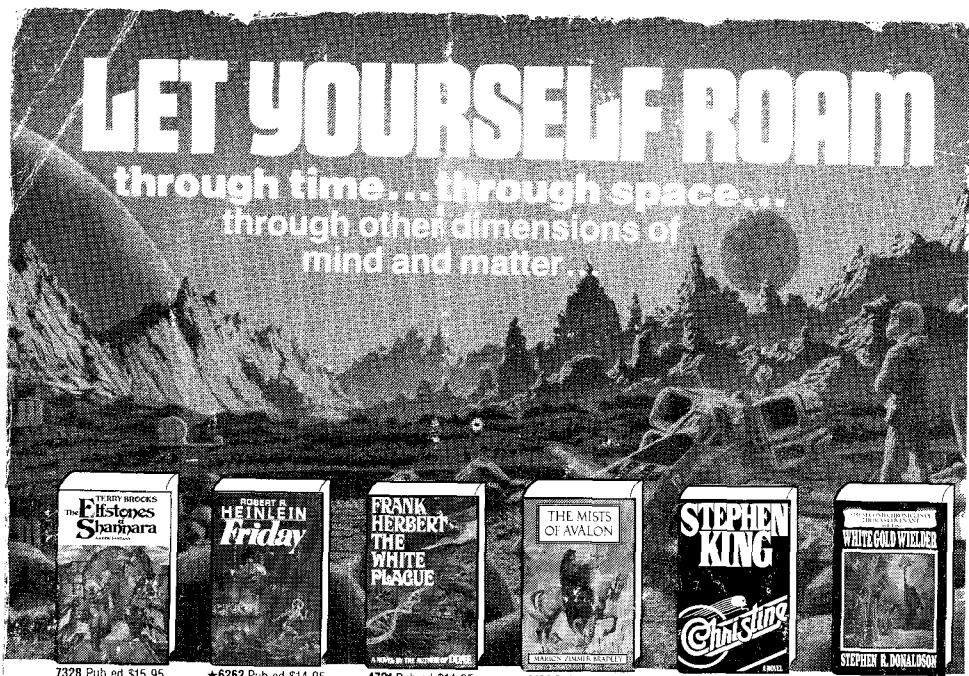

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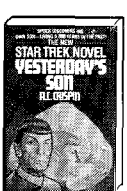

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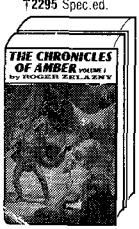

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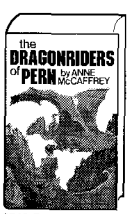

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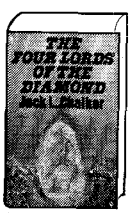

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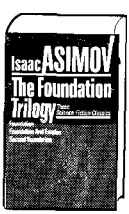

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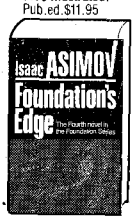

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